



FRUIT PRODUCTION RECOMMENDATIONS

2008-2009

Publication 360

Ministry of Agriculture,
Food and Rural Affairs



Discard old editions of this publication. Each year the appropriate sub-committee of the Ontario Pest Management Research and Services Committee reviews the pesticides listed in this publication. To the best knowledge of the committee, at the time of printing, the pesticide products listed in this publication were:

- federally registered
- classified by the Ministry of the Environment.

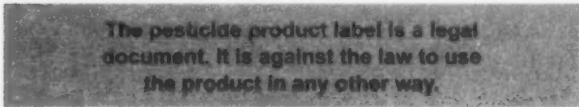
The information in this publication is general information only. The Ministry of Agriculture, Food and Rural Affairs does not offer any warranty or guarantee, nor does it assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

This publication lists a number of brand names of pesticides. It is neither an endorsement of the product nor a suggestion that similar products are ineffective.

The Pesticide Label

Consult each product label before you use a pesticide.

The label provides specific information on how to use the product safely, hazards, restrictions on use, compatibility with other products, the effect of environmental conditions, etc.



The pesticide product label is a legal document. It is against the law to use the product in any other way.

Federal Registration of Pesticide Products

The Pest Management Regulatory Agency (PMRA) of Health Canada registers pesticide products for use in Canada based on following an evaluation of scientific data to ensure that the product has merit and value; and the human health and environmental risks associated with its proposed use are acceptable.

1. Full Registration

Pesticide registrations are normally granted for a period of five years, subject to renewal.

2. Temporary Registration

Temporary registration may be granted for a period not to exceed one year, where the registrant agrees to produce additional scientific or technical information, or the pesticide is used for emergency control of a serious pest outbreak.

Maximum Residue Limits

Health Canada has established maximum residue limits (MRLs) for pesticides. Processors or retailers may demand more restrictive limits. Growers should seek advice of their intended market to determine if more restrictive limitations apply. Keep accurate and up-to-date records on pesticide use in each crop.

Supplemental Labels

You **MUST** obtain a supplemental label and follow all the label directions when PMRA approves new uses for a registered pesticide that do not appear on the current label.

Examples of when you must use a supplemental label include:

- **Temporary Registrations for Emergency Use**
- **Minor Use Label Expansion**

You can obtain a copy of a supplemental label from the pesticide manufacturer or pesticide vendor, the grower association that sponsored the emergency registration or minor use, from OMAFRA or PMRA's Pest Management Information Service.

For more information on the federal registration status check the PMRA website at www.hc-sc.gc.ca/pmra-arla or call 1-800-267-6315.

Regulation of Pesticides in Ontario

The Ministry of the Environment is responsible for regulating pesticide sale, use, transportation, storage and disposal in Ontario. Ontario regulates pesticides by placing appropriate education, licensing and/or permit requirements on their use, under the *Pesticides Act* and Regulation 914.

All Pesticides must be used in accordance with requirements under the *Pesticides Act* and Regulation 914. The act and Regulation are available on the e-laws website at www.e-laws.gov.on.ca or call Publications Ontario Toll-Free number: 1-800-668-9938 or 416-326-5300.

Classification of Pesticides

The Ontario Pesticides Advisory Committee (OPAC) is responsible for reviewing and recommending to the Ministry of the Environment, the placement of pesticide products into one of six schedules used to control sale and use. Once approved by the Ministry of the Environment, classified products are posted on the OPAC website: www.opac.gov.on.ca. For more information call OPAC at 416-314-9230.

Certification and Licensing

Growers and their Assistants

For information about certification for growers and training for assistants check the Ontario Pesticide Education Program website: www.ridgetownc.uoguelph.ca/oep/ or call 1-800-652-8573.

Commercial Applicators and their Assistants

For more information about exterminator certification and licensing and technician training check the Ontario Pesticide Training & Certification website at www.ridgetownc.uoguelph.ca/optc or call 1-888-620-9999.

Cette publication est aussi disponible en français.



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Need technical or business information?

**Contact the Agricultural Information Contact Centre at:
1-877-424-1300 or ag.info.omafra@ontario.ca**

Find it on the OMAFRA website

Technical information for Ontario fruit growers can be easily accessed on the OMAFRA website. Now it's easier than ever to find – just go to the OMAFRA Crops page at

ontario.ca/crops

Click on *Newsletters* for:

- Hort Matters
- Ontario Berry Grower
- Tender Fruit and Grape Vine
- Orchard Network

Click on *Crop Publications* for:

- Publication 360, Fruit Production Recommendations
- Publication 75, Guide to Weed Control
- Supplements to printed publications

Click on *Subscribe to OMAFRA E-mail Notices* if you wish to receive an e-mail notice when new information on fruit and vegetable crops is posted on the OMAFRA website.

- OMAFRA Fruit & Vegetable Crops Notice
- OMAFRA Sound Advice (Audio & Text Updates; Podcast)
- OMAFRA Berry Bulletin
- OMAFRA Vegetable Crop Updates
- OMAFRA Agricultural Business Update

Acknowledgements

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- Ontario Pest Management Research & Services Committee
- Ontario Pesticide Education Program
- Ontario Horticultural Research & Services Committee
- Ontario Soil Management Research & Services Committee

and personnel of:

- Agriculture Development Branch, OMAFRA
- CropLife Canada
- University of Guelph
- Brock University CCOVI
- Ontario Ministry of the Environment
- Agriculture and Agri-Food Canada
- several private consulting businesses

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1. Precautions with Pesticides

Read the product label before using a pesticide!

Review the Grower Pesticide Safety Course Manual.

Keep detailed spray records.

Pesticide Regulations

Before a pesticide can be sold or used in Canada, it must be registered under the federal *Pest Control Products Act (PCP Act)*. The *PCP Act* registration number on the front panel of the label identifies the pesticide and tells you that the pesticide is registered and can be legally used in Canada. It also indicates that the Pest Management Regulatory Agency (PMRA) completed their scientific review of the pest control product, found that the product has value, and has assessed and found acceptable the potential hazards to the environment and human health when following the label directions.

The pesticide label is a legal document; it tells you how the pesticide can be legally used. Off-label use is prohibited. It is against the law to use the pesticide in any other way or on any other crop or pest. You can find the labels for all registered pesticides on the PMRA website at www.pmra-arla.gc.ca.

For more information about pesticide regulations, refer to:

- Inside front cover of this publication
- PMRA website: www.pmra-arla.gc.ca
- PMRA Pest Management Information Service: 1-800-267-6315 (within Canada) or 1-613-736-3799 (outside of Canada)
- Ontario Ministry of the Environment (MOE) website at www.moe.gov.on.ca
- Your regional MOE Pesticides Specialist. See Appendix F, *Ontario Ministry of the Environment Regional Offices Contact Information*, on page 218

Pesticide Application Information

Read the pesticide label thoroughly before application. The label provides important information, such as:

- directions of use (rates of application, crops it can be used on, target pests, crop rotation restrictions, total number of applications)
- necessary personal protective equipment
- health hazards and toxicity
- re-entry intervals
- buffer zones
- special warnings
- steps to be taken in case of an accident
- disposal

For more information on hazards, check the Material Safety Data Sheet (MSDS) or contact the manufacturer. The Ontario Pesticide Education Program's *Grower Pesticide Safety Course Manual* is another resource for pesticide application information.

Re-entry intervals

The re-entry interval, also referred to as Restricted Entry Interval (REI), is the period of time following a pesticide application during which workers must not enter the treatment area without wearing protective clothing and personal protective equipment. This allows any pesticide residue and vapours to dissipate from the field, preventing the possibility of inadvertent pesticide poisoning.

Health Canada reviews each pesticide to determine whether the label should include a specific re-entry interval. If no re-entry interval is stated on the label, assume that the spray solution must be dry before re-entry can occur. Some pesticides labels carry a warning about working in treated crops. Follow the label recommendations. See Table 9-2, *Re-entry Intervals for Pesticides and Plant Growth Regulators*, on page 187.

Days to harvest (preharvest intervals, pregrazing and feeding intervals)

These intervals state the minimum time that must pass between the last pesticide application and the harvesting of the crop, or the grazing or cutting of the crop for livestock feed. If you harvest a crop before the preharvest interval has passed, there may be pesticide residues in excess of the Maximum Residue Limits (MRL) set by Health Canada. See Table 9-3. *Number of Days from Last Spray to Harvest*, on page 189.

To avoid exceeding the Maximum Residue Limits (MRL), always follow the directions on the label.

Protect the Environment

Protect water sources

Mix pesticides and load the sprayer away from any water supply, including wells, ponds or streams.

Clean your spray equipment away from wells, ponds, streams and ditches. Apply the diluted rinse water to the treatment area (crop).

If you must take water from wells, ponds, streams or other sources, use an anti-backflow device to prevent back-siphoning.

Sweep granular pesticides off driveways and hard surfaces, back into the treated area, to prevent them from contaminating water sources.

Setback distances for water bodies

It is an offence under the federal *Fisheries Act* to introduce any material into water that may be harmful to fish or fish habitat. To protect these waters, applicators must determine a suitable setback distance between the area to be protected and the area where pesticide treatments are planned. The protected area includes the water body as well as adjacent riparian (riverbank) areas that contribute to fish food and habitat.

Prevent bee poisoning

It is important to protect bees when you spray. Honeybees, as well as other bees and insects, are important pollinators of crops. Many crops also offer bees important sources of nectar for honey production.

Most organophosphate and carbamate insecticides are highly toxic to bees. Read each pesticide label for specific precautions regarding bees. For more information, please refer to Table 9-4. *Relative Toxicity of Pesticides to Honeybees*, on page 193.

Manage drift

- Do not spray when wind speeds are high or gusty.
- Read the product label for information regarding buffer zones, sprayer output (water volume) and recommended nozzles.
- Use the recommended sprayer output (L/ha).
- Use the most appropriate nozzle for the type of application. Where practical, use air induction/venturi nozzles, which significantly reduce drift when compared to conventional nozzles.
- Check the height of the boom to the target. Minimize the distance as much as possible.
- Do not apply pesticides if the wind is blowing towards susceptible crops or environmentally sensitive areas such as watercourses.
- Use spray plume protection where practical or available (hoods, shrouds, screens and air curtains).
- Use drift-reducing adjuvants in the spray tank as directed by the label.
- Use wick weeders, instead of spraying, when possible.
- Use non-volatile pesticides.

For more information about spray drift:

OMAFRA/Agriculture and Agri-Food Canada booklet *Best Management Practices – Pesticide Storage, Handling and Application*, BMP 13.

Ontario Pesticide Education Program (Ridgetown College) videos *How to Manage Spray Drift* and *Spray Drift Reduction Through Air Induction*.

Order videos on-line at www.opep.ca/Educational/EducationalMaterials.htm.

Buffer zones

Leave a suitable **buffer zone** between the treatment area and adjacent sensitive areas. Buffer zones are areas left untreated to protect an adjacent sensitive area, aquatic system or natural habitat.

Adjacent sensitive areas include cultivated plants grown for human consumption, plants sensitive to herbicide drift, trees or shrubs that may be damaged by herbicides leaching to roots, and areas where children play.

Aquatic systems include lakes, reservoirs, streams, creeks, ditches, marshes, wetlands, ponds, well heads, commercial fish ponds, etc.

Natural habitats include hedgerows, grasslands, shelterbelts, windbreaks, woodlots, vegetative strips, etc.

Some pesticide labels specify buffer zone requirements. See Table 9-5. *Examples of Buffer Zones for Pesticides Used in Publication 360*, on page 194.

Pesticide Disposal**Empty pesticide containers**

Never reuse empty containers.

The Ontario Pesticide Container Recycling Program is available to growers and commercial applicators. Through this program, clean, triple rinsed, plastic/metal pesticide containers (up to 23 L for plastic and 20 L for metal) can be returned to pesticide container depots located throughout the province. To locate the pesticide container recycling depot closest to you, call the Ontario Pesticide Education Program at 1-800-652-8573.

Surplus spray mix

The best way to dispose of any excess spray mix is to find other fields that require an application of this pesticide. Before spraying, check the label to make sure the pesticide is registered for use on that crop.

If you cannot find another field to spray, then dilute the remaining spray mix by adding 10 parts of water for each 1 part of spray mix. The diluted solution can be safely applied to the treated area as long as you do not exceed the pesticide rate recommended on the label. Be sure to check the label for any restrictions about crop rotation, days to harvest or surplus spray mix disposal.

Never re-spray the treated field with undiluted spray mix. Spraying an area twice will double the recommended pesticide rate. This may cause illegal pesticide residues in the harvested crop or harmful residues in the soil that can cause crop damage.

Surplus pesticides in storage

If you have pesticides that you don't need or can't use, be sure to dispose of them safely.

Contact the supplier. It is sometimes possible to return an unused pesticide if it is still in its original container.

If you cannot find a way to use the product as shown on the label, then the waste must be disposed of by waste haulers licensed under Part V of the *Environmental Protection Act* to carry hazardous wastes. Look in the Yellow Pages of your telephone directory under Liquid Waste Removal. Watch your local paper for obsolete pesticide collection days.

Storing pesticides

Ontario's *Pesticides Act* and Regulation 914 give storage requirements for storage facilities. The storage requirements that must be followed depend on which schedules of pesticides that you store.

For more information about storing pesticides:

OMAFRA Factsheet, *Pesticide Handling Facility*, Order No. 94-037

Ontario Pesticide Education Program (Ridgetown College) *Grower Pesticide Safety Course Manual*

Emergency Procedures for Pesticide Poisoning and First Aid Information

See inside back cover.

Pesticide Spills

If a pesticide spill causes, or is likely to cause, an adverse effect, you must notify the Ministry of the Environment Spills Action Centre at 1-800-268-6060 (24 hours a day, 7 days a week) and your municipality (Regulation 914, s. 29).

Protect yourself before beginning to clean up any spill. Clean up spills immediately.

In the case of **minor spills**:

- For liquids, cover the spill with a thick layer of absorbent material such as kitty litter, vermiculite

or dry soil. Sweep or shovel the material into a waste drum.

- For powders and granular, sweep or shovel the material into a waste drum.

In the case of a **major spill**:

- Remove any people or animals from the spill area. Stop the spill from spreading. Do not let the pesticide enter any watercourse.

For information on preventing spills, see the OMAFRA Factsheet, *Ways to Avoid Pesticide Spills*, Order No. 96-025.

2. Pest Management

Integrated Pest Management

Integrated Pest Management (IPM) is an approach to pest control that considers all management options to maintain pests below an economic injury level. Tools for pest management include cultural, physical, biological, behavioural and chemical methods. With IPM, adverse effects of pesticides are minimized and economic returns are maintained.

IPM programs make extensive use of information collected in the cropping system and require careful management by the grower. To implement an IPM program you must understand:

- pest identification, biology and behaviour
- beneficial organisms
- monitoring techniques
- use and timing of appropriate management tools
- record keeping
- resistance management strategies
- sprayer calibration

This publication outlines integrated approaches to pest control and includes the use of pesticides, biological controls, cultural management tools and resistance management strategies.

Monitoring

Systematic monitoring of pest populations, weather conditions, plant health and disease symptoms are critical components of an IPM program. Monitoring or scouting results can be subjective and are best done by the same person or service. Information on field history, soil type, spray records and weather is important when you interpret results. Records are important for comparison of the situation from year to year.

Tools needed to monitor pests:

- a 16–20× hand lens
- traps, which include pheromones, sticky cards, tapping trays, sweep nets
- collection bags and vials

- field maps, which indicate varieties, age of planting, surrounding vegetation and features
- flag tape
- shovel or sturdy trowel
- pocket knife
- scouting forms and record sheets

For a list of monitoring equipment suppliers, see Appendix A. *Suppliers of Pest Monitoring Equipment and Biological Control Agents*, on page 209.

Monitoring strategies:

- Learn to identify life stages and damage caused by disease and pests.
- Understand the biology and life cycle of pests and disease.
- Recognize beneficial insects, as well as harmless insects.
- Use historical data to identify hot spots and previous problems.
- Keep a field map and record the location of damage.
- For each visit, record the stage of crop development, disease severity, population levels of insect pests and beneficials, and damage observed.
- Keep a journal or log of rainfall amounts, daily highs and lows, and weather events.
- Keep a record of pesticides applied and other control measures used.

Monitoring procedures:

- Review pest control calendars to know when certain pests will be active.
- Monitor at least once a week and preferably twice a week during critical stages.

- Monitor at approximately the same time each day and keep the light behind you.
- Inspect plants in several areas across the field to get an accurate idea of pest pressure.
- Stand back and look for patterns, such as patches or areas of poor plant growth or where colour is off.
- Get close and examine fruit clusters, the underside of leaves, inside the canopy, etc.
- Scout the edges of the field and interior of the field separately.
- Give special attention to border areas near wild hosts, such as wild fruit trees, grapevines or raspberries. Many insect pests overwinter in these areas.
- Be aware of variety and rootstock changes and inspect these separately if necessary.

Sampling

Sample collection involves the collection of data to represent the entire area being monitored.

- Divide large areas into sample blocks no larger than 8–10 ha for tree fruit and grapes, and 2.5 ha for berry crops. Cultivar, training system, plant density, soil type, topography and age of the planting should be as consistent as possible in each sample block.
- Walk in a W or zig-zag pattern across the field to collect samples from a representative area. Truly random sample collection is rarely practical in field inspection.
- Look away from the plant when you take samples of leaves and fruit, otherwise you will tend to choose damaged leaves or fruit and bias the sample.

Thresholds

An IPM program uses control guidelines or thresholds to indicate when to apply pesticides to prevent economic loss. In other words, some damage to the crop is tolerated as long as this damage does not exceed the cost of the control.

For insect pests, thresholds are usually based on the presence of the pest at certain levels. Thresholds for direct pests, which feed on fruit and have an immediate effect on fruit quality, are generally lower

than thresholds for indirect pests that feed on leaves, stems or roots.

For diseases, guidelines may be based on the pest's damage potential. This is estimated through the use of weather models, crop tolerance, stage of crop development and field observations.

Thresholds have not been developed or validated for all pests in Ontario. Even established thresholds require adjustment for different varieties, markets and crop vigour. Established thresholds may also require revision to optimize the use of new, reduced-risk products.

Use the thresholds in Table 2-1. *Examples of Thresholds Used for Fruit Pests in Ontario*, on page 7, together with information on sampling techniques and sample size, crop phenology, spray times and pesticide characteristics discussed in detail in each crop chapter.

Trapping

Use traps and monitor insects to provide:

- information on pest activity
- information on insect numbers
- validation of degree-day models, which predict insect emergence
- information to optimize spray timing

Most traps catch only the adult stage of the pest and may not provide information on the destructive larval stage.

Pheromone traps

Volatile chemicals emitted to attract the opposite sex are known as sex pheromones. For some insects these unique chemicals have been identified and synthetically produced into lures, which are placed in sticky traps and attract male insects of a specific species.

Use pheromone traps to determine the presence or absence of pests and the first sustained flight or activity peaks of certain pests. Pheromone traps are less useful for providing information on population levels.

To determine the first sustained catch in pheromone traps, ignore early sporadic catches. A sustained catch is the start of a continual period of moth activity, which continues for at least two successive

TABLE 2-1. Examples of Thresholds Used for Fruit Pests in Ontario

Crop	Pest	Spray Timing	Minimum Sample Size	Threshold	Comments
Strawberries	Tarnished plant bug	Bloom-green fruit	20 clusters	Approx. 0.25 nymphs per cluster	Sequential sampling methods are preferred. See OMAFRA Factsheet, <i>Tarnished Plant Bug: A Major Pest of Strawberries</i> , Order No. 92-108 on the OMAFRA website at ontario.ca/crops .
Strawberries	Clipper weevil	Before 1st bloom	5 locations	13 clipped buds per 2 ft ² row	Sample outer rows.
Strawberries	Two-spotted spider mite	Before harvest, or July-August	50 leaflets	Low threshold: 5 mites per leaflet High threshold: 20 mites per leaflet	Use low threshold on sensitive varieties before bloom or when using beneficial mites for control. Use high threshold after harvest.
Raspberries	Raspberry crown borer	October, or when primocanes begin to grow in spring	Entire block	5% of canes with die back	
Apples	Mullein bug	Petal fall to calyx	25 taps per block	7 to 9 nymphs per 25 taps	Sample susceptible varieties such as Red Delicious and Northern Spy.
Apples	Spotted tentiform leafminer	Pink to calyx	50 spurs	3 to 5 eggs per spur	Apply insecticide at first egg hatch.

collection periods. When first sustained catch is used as a biofix, it is important to have pheromone traps set for one to two weeks before first flight of the pest is expected.

Visual attractants

Yellow sticky boards and red spheres are attractive to certain insects, especially flies, because they provide a visual stimulus. These traps reflect wavelengths of light recognized by the insect and can be used to indicate the presence and relative abundance of a pest.

How to use traps

- Place traps in the field one to two weeks before the expected emergence of the insect.
- Follow pest-specific guidelines in regard to the number and location of traps for the crop.
- Clear foliage and branches away from the trap.
- Use separate traps for each species and label traps clearly.
- Pheromone lures are pest-specific. They are very sensitive to contamination from other types of pheromones. When you use several types of pheromones at once, wear disposable latex gloves to prevent cross-contamination and maintain a minimum of 40 m between traps, or the distance recommended by the manufacturer, to avoid interference.
- Use flagging tape to clearly mark the location of traps.
- Check traps twice weekly and record the number of pests caught. Remove the insects at each visit.
- Traps require maintenance. Replace the trap when it becomes too dirty or no longer sticky. When you replace traps, simply transfer the old lure into the new trap.
- Pheromone lures generally have a 3–6 week life span but longevity varies with different products. Replace the lures according to the manufacturer's instructions. Store unopened, unused pheromone lures in the refrigerator.

**TABLE 2-2. Examples of Traps Used
for Monitoring Fruit Pests**

Pest	Crop	Type of Trap
Codling moth	Walnuts	CM pheromone Diamond traps
Walnut husk maggot fly	Walnuts	Yellow sticky cards
Currant fruit fly	Currants, gooseberries	Yellow sticky cards
Cranberry fruitworm	Blueberries	Cranberry fruitworm pheromone Wing traps
Cherry fruitworm	Blueberries	Cherry fruitworm pheromone Wing traps
Sharp-nosed leafhopper	Blueberries	Yellow sticky cards
Blueberry maggot	Blueberries	Yellow sticky cards
Oblique banded leafroller	Apples, pears	Pheromone Diamond traps
European apple sawfly	Apples	3-D white sticky traps

For a list of trap and pheromone suppliers, see
**Appendix A. Suppliers of Pest Monitoring Equipment
and Biological Control Agents**, on page 209.

Degree-day modelling and determining a biofix

Temperature, light and moisture affect the growth and development of plants and their pests. Of these, temperature is the most important factor. Insect and mite development is closely related to the daily accumulation of heat. These pests need a certain amount of heat, or energy, to move to the next development stage.

The amount of heat required for insect and mite development remains constant from year to year, but depending on weather conditions, the amount of actual time can vary. Insects and mites have a minimum and a maximum base temperature below or above which development does not occur. These base temperatures are different for each organism.

Growing Degree-Days (GDD) are used to estimate the growth and development of pests in the growing season. Events such as egg-laying, egg hatch, movement of crawlers or the appearance of disease can be predicted and used to schedule inspection and spray programs. For example, degree-day calculations can

predict the first flight of codling moth adults or the percentage of apple scab ascospores that have matured in the orchard.

There are several methods used to calculate GDD, but the method commonly used with simple monitoring equipment is the averaging method or “max/min” method. GDD for a given organism are calculated as follows:

$$\text{GDD} = \frac{(\text{Daily max } ^\circ\text{C}) + (\text{Daily min } ^\circ\text{C})}{2} - \text{minimum base temperature}$$

GDD are accumulated daily until a pest-specific total is reached. The averaging method works quite well in most years but can lead to errors in application time during long, cool springs or very hot summers because it can either underestimate the actual GDD in cool weather or overestimate it in hot weather.

An example of the averaging method on a relatively cool spring day:

For a given pest:

Lower base temperature = 10°C
Upper base temperature = 35°C

On a given day:

Minimum temperature = 5°C
Maximum temperature = 15°C

Growing degree-days (GDD) for
that day is = $(15+5)/2 - 10 = 0$

Note that the maximum temperature was higher than the base temperature for the insect, so growth and development were possible for at least part of the day. However, no GDD were accumulated. This illustrates how cool temperatures, especially over several days, could lead to an underestimation of insect development.

GDD are either accumulated from a set start date, such as April 1, or from a specific event known as a biofix. A common biofix used for insects is the first sustained catch in pheromone traps.

Use of a biofix provides more accurate predictions and requires tracking temperatures over a shorter period of time.

There are several limitations to degree-days models:

- Factors such as humidity, light intensity and rainfall also affect pest development. As a result, GDD predictions are only estimates of pest development. The prediction must be verified with field observations.

- Temperatures used to determine GDD must represent the environment where organisms develop. Use weather data collected from within a mile or less of the actual orchard or field being monitored.
- GDD have been developed and validated for only a few fruit pests in Ontario.

TABLE 2-3. Examples of Degree-Day Models Used in Fruit Crops

Pest	Model
Tarnished plant bug (strawberries)	Degree-days are used to predict first nymphs in strawberries 30–40 GDD (base 12.1°C) after April 1
Codling moth (apples)	Degree-days are used to predict first egg hatch 100 GDD (base 11°C) after biofix (first sustained moth catch)

For a list of crop consultants that provide monitoring services, contact OMAFRA's Agricultural Contact Centre at 1-877-424-1300.

Pest management tools

Cultural pest controls

Many crop management practices can prevent or delay the development of pest outbreaks. Follow these cultural control tools:

- Choose sites less favourable for pest development. Avoid planting in poorly drained locations.
- Select cultivars less susceptible to disease or insect pressure.
- Rotate to a non-host crop where possible to break the pest cycle. Some insects and many diseases overwinter in crop refuse.
- Use plants tested and determined to be free from disease or virus.
- Remove all sources of the pest, such as cull piles and dropped fruit, from the field or orchard.
- Maintain good weed control and eliminate wild hosts from within as well as the perimeter of the planting. Weeds and wild fruit trees, grapevines and brambles often act as alternate hosts to many crop pests.

- Use non-related crops planted in close proximity as a barrier to insects and diseases. Avoid intercropping plants with similar pest complexes.
- Modify insect habitat through the introduction of cover crops to promote beneficial organisms.
- Prune and remove infected plant material to reduce pest pressure. Pruning and training plants to improve air movement within the canopy will also improve spray coverage.
- Timely irrigation can reduce plant stress during drought and increase plant tolerance to pests. Schedule irrigation so that plants are not wet overnight.
- Manage nutrients to avoid excessively lush growth, which is more susceptible to some diseases and more attractive to some insect pests.

Chemical controls

Chemical controls include synthetic, inorganic, botanical and biological pesticides. They kill target pests, limit subsequent populations and are important tools for crop protection when used in an IPM program.

Understand the pest's life cycle and apply chemicals at the stage when the pest is most vulnerable.

- To manage insects and mites, monitor blocks closely and spray according to action thresholds established for each species.
- To manage disease, apply protective fungicides when weather conditions are favourable and before damage occurs.

Biological control

Biological control uses a pest's natural enemies to help suppress pest populations. These natural enemies, collectively known as beneficials, may be predatory insects, parasites, pathogens or nematodes. Beneficials are most effective against indirect pests such as aphids, leafhoppers and mites. They are less effective at keeping populations of direct pests, which attack the harvested product, at levels acceptable for commercial production. Important beneficial insects and mites in Ontario fruit crops include ground beetles, mullein bugs, minute pirate bugs, lacewings, lady bird beetles and phytoseiid mites.

Natural enemies can be adversely affected by the crop environment and the pesticides used to manage

pest populations. IPM programs attempt to minimize adverse effects of pesticides on beneficials and take advantage of the pest suppression these insects provide.

- Avoid use of pesticides that are toxic to the most important beneficials in a cropping system. See *Prevent Bee Poisoning*, on page 2.
- Encourage a diverse habitat around the perimeter of the field where beneficial insects can live. Small flowering plants are an important food source for parasitic wasps.
- Avoid ultra-clean cultivation. Crop residue, mulch or ground cover will encourage ground beetles and other important predators in the soil.

For additional information on predators and parasitoids, see OMAFRA Publication 208, *Predatory Insects in Fruit Orchards* or OMAFRA Factsheet, *Beneficial Insects in Tree Fruit Orchards in Southern Ontario*, Order No. 96-029.

Biological controls can be purchased for control of certain pests. Beneficial nematodes are being used experimentally to control root weevils in berry crops. Predatory mites can be purchased and released in orchards and berry crops for control of spider mites.

Product quality and shelf life are important considerations when you purchase and use biological control agents. For sources of beneficial insects and mites, check the OMAFRA website at ontario.ca/crops.

Mating disruption

Many adult insects emit volatile chemicals known as sex pheromones to attract members of the opposite sex. When a female moth secretes these chemicals, males use the pheromone trail or plume to pinpoint her location. Synthetically-produced sex pheromones can be used in traps to monitor insect activity patterns.

Mating Disruption (MD) technology uses these same chemicals to confuse males and limit their ability to locate calling females. The release of large quantities of synthetic sex pheromone into the crop atmosphere interferes with mate location by masking the trail or pheromone plume. Mating is either delayed or prevented because the probability of males finding females is reduced. Consequently, fewer

larvae are present to cause crop damage. Synthetic pheromones used in mating disruption are a form of biological control.

For additional information on synthetic pheromones and their use in pest management, see:

- OMAFRA Factsheet, *Mating Disruption for Management of Oriental Fruit Moth in Stone Fruit and Pome Fruit*, Order No. 04-029
- OMAFRA Factsheet, *Mating Disruption for Management of Insect Pests*, Order No. 03-079
- *Mating disruption (MD) technology for management of grape berry moth*, on page 139

Particle film technology

Particle film technology protects crops from certain insects, heat stress and sunburn by coating plant surfaces with a white particle barrier film. Surround WP Crop Protectant is registered in Canada for use in apples, pears, grapes and cucumbers for several insect pests. The active ingredient in Surround WP Crop Protectant is kaolin clay, a non-toxic compound that leaves a white, powdery film on the surface of leaves, stems and fruit. This film acts as a barrier between the pest and the host plant. Insects that come into contact with Surround-treated crops may either be repelled or disoriented, which makes the host unrecognizable or unsuitable for feeding.

Good spray coverage is essential when using Surround. The fruit and/or leaves must be completely covered with the product, so re-application may be necessary after heavy rainfall. Light to moderate rains will aid in the uniform distribution of the particle film on leaf and fruit surfaces without the removal of large amounts of residue.

During the growing season, Surround-treated tree and grape canopies take on a bluish-green hazy look.

Precautions when using Surround

- Do not mix Surround with spreaders, stickers or anti-foaming agents.
- Do not spray when bees are active.
- Do not re-enter the treated area for four hours after application.

In orchards treated with Surround, use starch iodine tests to monitor fruit maturity in the last two weeks of crop development. For grapes, Surround may

delay brix accumulation. Closely monitor harvest parameters to determine optimal time to harvest.

For detailed application instructions, see the product label.

Reduced-risk pesticides and biopesticides

Many IPM programs for fruit crops were developed using older, broad-spectrum pesticides to manage key economic pests. The number of reduced-risk and biopesticide alternatives available for use in Canada continues to increase.

Reduced-risk pesticides are products that present a reduced risk to human health and the environment, when compared to other alternatives. These pesticides are of interest because they have some of the following characteristics:

- low risk to human health
- low toxicity to non-target organisms
- low potential to contaminate ground water, surface water or other valued environmental resources

The use of reduced-risk pesticides should help to improve integrated pest management strategies.

Biopesticides are pesticides derived from natural materials such as animals, plants, bacteria and minerals. While many are less toxic and pose a lower risk than conventional pesticides, others can be quite toxic. Biopesticides include microbial pesticides and biochemical pesticides.

Microbial pesticides contain beneficial microorganisms like bacterium, fungus, virus or protozoan as the active ingredient. They are relatively specific to their target pest and include the various subspecies and strains of *Bacillus thuringiensis*.

Examples of microbial pesticides used on fruit crops in Ontario are:

- Dipel 2X DF, Foray 48 BA and Bioprotec CAF (contain *Bacillus thuringiensis*)
- Virosoft (*Cydia pomonella* or codling moth granulosis virus)
- Bloomtime Biological FB and Blightban C9-1 (contain strains of *Pantoea agglomerans*)

Biochemical pesticides are naturally occurring substances that control pests by non-toxic mechanisms. Examples of biochemical pesticides used on fruit crops in Ontario are:

TABLE 2-4. Examples of Reduced-Risk Pesticides Used on Fruit Crops in Ontario

Product name	Active ingredient	Type of product/use
Acramite 50 WS	bifenazate	miticide
Apogee	prohexadione calcium	plant growth regulator
Assail 70 WP	acetamiprid	insecticide
Confirm 240 F	tebufenozide	insecticide
Elevate 50 WDG	fenhexamid	fungicide
Flint 50 WG	trifloxystrobin	fungicide
Intrepid 240 F	methoxyfenozide	insecticide
Lance WDG	boscalid	fungicide
Ridomil Gold 480 EC	mefenoxam (active isomer of metalaxyl)	fungicide
Scala SC	pyrimethanil	fungicide
Success 480 SC	spinosad	insecticide
Entrust 80 W		
GF-120 NF		
Switch 62.5 WG	cyprodinil + fludioxonil	fungicide
Vanguard 75 WG	cyprodinil	fungicide

Source: Pest Management Regulatory Agency (PMRA) Reduced Risk Update Document RR2007-01 Update on Reduced Risk Pesticides in Canada can be found at www.pmr-arla.gc.ca/english/pdf/rr/rr2007-01-e.pdf. The Pest Management Regulatory Agency Initiative for Reduced-Risk Pesticides (Regulatory Directive DIR2002-02) can be found at www.pmr-arla.gc.ca/english/pdf/dir/dir2002-02-e.pdf.

TABLE 2-5. Biopesticides Registered in Ontario Fruit Crops

Product name	Active ingredient	Type of product/use
Accel	benzyladenine	plant growth regulator
Bioprotec CAF	<i>Bacillus thuringiensis</i> Berliner ssp. <i>Kurstaki</i>	insecticide
Biosafe StorOx	hydrogen peroxide	bactericide/fungicide
Blightban C9-1	<i>Pantoea agglomerans</i> C9-1	bactericide
Bloomtime Biological FB	<i>Pantoea agglomerans</i> E325	bactericide
Deer-Away	putrescent whole egg solids	deer deterrents
Dipel 2X DF	<i>Bacillus thuringiensis</i> Berliner ssp. <i>Kurstaki</i>	insecticide
Dygal	<i>Agrobacterium radiobacter</i>	bactericide
Foray 48BA	<i>Bacillus thuringiensis</i> Berliner ssp. <i>Kurstaki</i>	insecticide
Isomate C-Plus Codling Moth Pheromone	codling moth pheromone	insect mating disruption
Isomate-CM/LR Pheromone	codling moth and leaf roller pheromone	insect mating disruption
Isomate-GBM Plus	grape berry moth borer pheromone	insect mating disruption
Isomate-M 100, Isomate-M Rosso	oriental fruit moth pheromone	insect mating disruption
Isomate-P Pheromone	greater peach tree borer pheromone	insect mating disruption
MilStop Foliar Fungicide	potassium bicarbonate	fungicide
Promalin	benzyladenine, gibberellins A ₄ , A ₇	plant growth regulator
ReTain	aminoethoxyvinylglycine hydrochloride	plant growth regulator
Safer's Insecticidal Soap	soap	insecticide/miticide
Serenade Max	<i>Bacillus subtilis</i> QST 713	bactericide/fungicide
Sluggo Slug and Snail Bait	ferric phosphate	slug control
SmartFresh Technology	1-Methylcyclopropene (1-MCP)	post-harvest
Surround WP Crop Protectant	kaolin	particle film technology
Virosoft	<i>Cydia pomonella</i> granulosus virus	insecticide

Source: Pest Management Regulatory Agency (PMRA) Reduced Risk Update Document RR2007-01 Update on Reduced Risk Pesticides in Canada can be found at www.pmr-arla.gc.ca/english/pdf/rr/rr2007-01-e.pdf. The Pest Management Regulatory Agency Initiative for Reduced-Risk Pesticides (Regulatory Directive DIR2002-02) can be found at www.pmr-arla.gc.ca/english/pdf/dir/dir2002-02-e.pdf.

- synthetically-produced insect sex pheromones used for mating disruption
- particle film technology using kaolin clay, such as Surround WP Crop Protectant
- spinosyns derived from the fermentation of a soil-dwelling bacterium *Sacharopolyspora spinosa* (Spinosad)

Not all products in Table 2-5, *Biopesticides Registered in Ontario Fruit Crops*, have been included in the crop calendars. More experience is required for the incorporation of these products into recommended Ontario IPM programs.

TABLE 2-6. Factors Favouring the Development of Resistance

Characteristics of the pest	Characteristics of the pesticide or use pattern
prolific life cycle, with many generations per year, and/or multiplying very quickly	persistent residues, exposing multiple generations to residues from a single spray
pre-existing resistance to other products in the same family	toxic to beneficials as well as the pest
narrow host range, spending entire life cycle on one crop	specific mode of action that works on a single site
no migration between crops or regions, gene pool is not diluted	used at excessive rates or improper timing

Pest Resistance to Insecticides, Fungicides, Miticides

Resistance occurs when a pest is able to survive exposure to rates of a pesticide that previously controlled it. Resistance to a pesticide may develop after an insect or disease is repeatedly exposed to a chemical or chemical group. A few naturally resistant individuals survive after each spray, while the susceptible portion of the population is killed. These resistant survivors multiply and pass their resistant traits on to the next generation. Gradually, resistant individuals replace the susceptible ones. Once the resistant population dominates, the pesticide loses efficacy.

Pest control failures are not necessarily caused by pesticide resistance. Before you assume a population is resistant to a product, consider the following factors: product selection, water volume, rate, calibration and coverage, timing, pH in spray tank water, time required for knockdown of pest, and weather conditions.

Resistance can be stable or non-stable:

- Stable resistance is the resistance to a pesticide or pesticide group that persists for many generations, even if that pesticide is not used for many years.
- Non-stable resistance is when a resistant population becomes susceptible again, over time, after use of a product is discontinued.

Pests resistant to one pesticide may also be resistant to:

- others within the same chemical family;
- pesticides from different chemical groups but with similar action sites (organophosphate and carbamate insecticides both act as acetylcholinesterase inhibitors); or,
- pesticides with very different action sites.

Cross-resistance to other compounds in the same group, or to pesticides in related groups, can be a problem when a pest develops resistance to any pesticide; it can even occur without previous exposure to other pesticides in the group. Cross-resistance involves a pre-existing tendency for resistance. In other words, cross-resistance to a new pesticide has already developed prior to its first use in the field, due to selective pressure from exposure to previously applied products (e.g. the OP azinphosmethyl and the IGR tebufenozide). The term cross-resistance is

also used to describe situations where resistance to one pesticide is always associated with resistance to another pesticide, even if the two have very different action sites.

Multiple resistance occurs when a pest is resistant to pesticides from different families or sites of action at the same time. It begins to develop through selective pressure or repeated exposure to the new pesticide, independent of resistance previously developed to one or more other pesticides.

Multiple resistance and cross-resistance create serious challenges to the success of integrated resistance management strategies.

Resistance can develop very quickly. Do not use the same product repeatedly unless it is used in rotation or combination with different products from a different chemical group.

- Many chemicals with the same active ingredients are marketed under different brand names. For example, the fungicide captan is marketed under the brand names Supra Captan 80 WDG and Maestro 80 DF.
- Different chemicals may also have the same mode of action. For example, both Assail and Admire have the same mode of action. To use Assail after Admire is equivalent to using Assail after Assail, since resistance to both chemicals develops at the same time. This can happen even if only one may have been used repeatedly. The same applies for products in the pyrethroid family.

For a list of chemical groups and their modes of action see Table 2-7. *Insecticide and Miticide Groups Based on Sites of Action*, on page 15 and Table 2-8. *Fungicide/Bactericide Groupings Based on Sites of Action*, on page 16.

Resistance management strategies

General resistance management strategies:

- Follow an integrated pest management program that makes use of a variety of different pest control strategies including monitoring and crop rotation, as well as cultural, biological, and chemical control options.
- Spray only when necessary. Use established thresholds where available.
- Spray at the best timing for the pest and the product being used.

- Apply recommended registered materials as directed. Use the labelled rate and water volumes. Select the best nozzles for the job and maintain a well calibrated sprayer.
- Read the product label. New products include resistance management recommendations on the label.

Specific strategies for managing resistance to insecticides:

- Rotate products from different chemical groups. Avoid sequential applications or repeated use of any pesticide or group of pesticides.
- Manage each generation of an insect pest as separate units. Use products from a single chemical group to manage a given generation of a pest. If the pest emergence and/or activity for that generation is prolonged, apply a second application of the same product. This exposes each generation to only one chemical group. Rotate to another chemical group (or groups) for subsequent generations, and if retreatments are necessary, choose a product in that same group.
- Avoid tank mixing different insecticides to manage a single pest, because it increases the probability that the target pest population will develop multiple resistance. Alternating products, rather than tank mixing them, is the preferred strategy for insecticides and miticides.
- Consider area-wide resistance management programs, especially for pests of more than one crop. Some insects are highly mobile.

Specific strategies for managing resistance to fungicides:

- Rotate products from different chemical groups. Do not exceed the recommended number of applications per season or sequential applications of a pesticide or group of pesticides, as specified on the label.
- Tank mixing products from different families is an accepted resistance management strategy for fungicides. Use only registered tank mixes (specified on the label).
- Apply fungicides before disease occurs. Follow disease prediction models when possible. Fungicides applied after the disease is established are more likely to select for resistant populations of the pathogen.

Resistance can be costly to the grower. The development and registration of new products is expensive and time-consuming. Judicious use of pesticides will help reduce the development of resistant populations and conserve the effectiveness of existing products.

Nematodes

Plant parasitic nematodes can cause significant yield losses to many horticultural crops. The extent of loss depends on the crop, nematode species and soil population level.

Common nematodes in Ontario fruit crops are root-lesion (*Pratylenchus*) and root-knot (*Meloidogyne*). The pin (*Paratylenchus* sp.) and dagger (*Xiphinema* sp.) nematodes occasionally cause yield losses to some fruit crops in isolated fields. The dagger nematode is mainly a virus vector on grape, raspberry and apple.

Symptoms of nematode injury include:

- uneven plant growth
- poor plant establishment
- weakened plants over time
- poor root growth
- knots or galls on roots
- excessive branching of roots, hairy root symptoms

On strawberries:

- Root-lesion nematodes cause discolouration of the fine feeder roots and tiny, brown, scratch-like lesions on the young white roots. These lesions merge to form large brown areas. Root-lesion nematodes are involved in black root rot and aggravate Verticillium wilt of strawberries and other host plants. Severely infected plants appear stunted and unthrifty.
- Root-knot nematode feeding stimulates root cells to enlarge. Enlarged cells look like small galls or beads (1 mm). As more and more nematodes establish feeding sites, they join together to become one larger root-knot.

On raspberries:

- Root-lesion nematode feeding causes scratch-like lesions on roots, similar to the symptoms on strawberry roots. Severely infested plants have thinner and fewer canes per crown. Up to 25% of first year canes may be killed by severe infestations of these nematodes.

TABLE 2-7. Insecticide and Miticide Groups Based on Sites of Action

Adapted from the Insecticide Resistance Action Committee (IRAC), Mode of Action Classification

Group or Subgroup	Primary Site of Action	Chemical family, sub-group or exemplifying agent	Product name	Active ingredient
1A ¹	Acetylcholine esterase inhibitors	Carbamate	Carzol SP Furadan 480 F Lannate Sevin XLR Plus Vydate L	formetanate hydrochloride carbofuran methomyl carbaryl oxamyl
1B ¹		Organophosphate	Cygon 480-AG Diazinon 50 W Diazinon 500 E Guthion Solupak Imidan 50 WP Lagon 480 E Lorsban 50 W Malathion 25 W Malathion 500 E Orthene 75% SP Sniper Zolone Flo	dimethoate diazinon diazinon azinphosmethyl phosmet dimethoate chlorpyrifos malathion malathion acephate azinphosmethyl phosalone
2A ²	GABA-gated chloride channel agonists	Chlorinated cyclodiene	Thiodan 4 EC Thiodan 50 WP Thionex 50 WP	endosulfan endosulfan endosulfan
3	Sodium channel modulators	Diphenylethane Pyrethroid	Kelthane 50 W Decis 5 EC Matador 120 EC Pounce Ripcord 400 EC	dicofol deltamethrin cyhalothrin lambda permethrin cypermethrin
4	Nicotinic acetylcholine receptor agonists	Neonicotinoids	Actara 25 WG Admire 240 F Alias 240 SC Assail 70 WP Calypso 480 SC	thiamethoxam imidacloprid imidacloprid acetamiprid thiacloprid
5	Nicotinic acetylcholine receptor agonists (allosteric, not group 4)	Naturalyte/Spinosyns	Success 480 SC Entrust 80 W GF-120 NF	spinosad spinosad spinosad
6	Chloride channel activators	Avermectin	Agri-Mek 1.9% EC	abamectin
10	Compounds of unknown or non-specific mode of action (mite growth inhibitors)	Tetrazine	Apollo SC	clofentezine
11	Microbial disruptors of insect midgut membranes	B.t. microbial	Bioprotec CAF Dipel 2X DF Foray 48BA	<i>Bacillus thuringiensis</i> <i>Bacillus thuringiensis</i> <i>Bacillus thuringiensis</i>
15	Inhibitors of chitin biosynthesis, type O, Lepidopteran	Benzoylureas	Rimon 10 EC	novaluron
18	Ecdysone agonist	Ecdysone agonist	Confirm 240 F Intrepid 240 F	tebufenozide methoxyfenozide
20B	Mitochondrial complex III electron transport inhibitors (Coupling site II)	Acequinocyl	Kanemite 15 SC	acequinocyl
21	Mitochondrial complex I electron transport inhibitors	Pyridazinone	Pyramite Nexter	pyridaben
23	Inhibitors of lipid biosynthesis	Tetronic acid derivatives	Envirdor 240 SC	spirodiclofen
25	Neuronal inhibitors (unknown mode of action)	Carbazate (aka carboxylic acid ester)	Acramite 50 WS	bifenazate

¹ All members of Group 1 may not be cross-resistant, although they share the same primary target site and mode of action. For this reason, Group 1 is divided into subgroups, Group 1A and 1B, each with different mechanisms of resistance. Assume that cross-resistance exists between pesticides in each sub-group, but that rotation of pesticides between sub-groups is an acceptable part of a resistance management program.

² Other resistance mechanisms that are not linked to site of action, (i.e. enhanced metabolism), are common for this group of chemicals. All members of this class may not have developed significant cross-resistance.

TABLE 2-8. Fungicide/Bactericide Groupings Based on Sites of Action

Adapted from the Fungicide Resistance Action Committee (FRAC) mode of action classification.

Group	Chemical family or group	Product Name	Active ingredient (* indicates the a.i. that puts it in this group)
1	MBC	benzimidazole	Mertec SC
		thiophanate	Senator 70 WP
2	Dicarboximide	Ronilan EG	vinclozolin
		Rovral WP	iprodione
3	DMI (this group is sometimes loosely known as sterol inhibitors)	piperazine	Funginex SC
		triazoles	Indar 75 WP
			Nova 40 W
			Nustar
			Mission 418 EC
4	Phenyl Amide (PA)	Topas 250 E	propiconazole
			propiconazole
7	Anilide carboxamide	Ridomil Gold MZ	metalaxyl* + mancozeb
		Ridomil Gold 480 SL	metalaxyl
9	Anilinopyrimidine	Lance WDG	boscalid
		Pristine WG	boscalid* + pyraclostrobin
12	Phenylpyrroles	Scala SC	pyrimethanil
		Vanguard 75 WG	cyprodinil
11	Qol (strobilurins belong in this group, but not all Qol fungicides are strobilurins)	Switch 62.5 WG	cyprodinil* + fludioxonil
		Scholar	fludioxonil
14	Chlorophenyl	Switch 62.5 WG	cyprodinil + fludioxonil*
17	Hydroxyaniline	Cabrio EG	pyraclostrobin
		Flint 50 WG	trifloxystrobin
		Sovran	kresoxim-methyl
		Pristine WG	boscalid + pyraclostrobin*
22	Benzamides	Tanos 50 DF	cymoxanil + famoxadone*
25	Antibiotic	Botran 75 W	dicloran
27	Cyanoacetamide-oxime	Elevate 50 WDG	fenhexamid
33	Phosphonate	Gavel 75 DF	mancozeb + zoxamide*
M1	Inorganic	Streptomycin 17	streptomycin
		Tanos 50 DF	cymoxanil* + famoxadone
		Aliette	fosetyl al
		Copper 53 W	tri-basic copper sulphate
		Guardsman copper	copper from copper oxychloride
M2	Dithiocarbamate	oxychloride	
		Copper spray	copper from copper oxychloride
		Kumulus DF	sulphur
		Lime Sulphur	lime sulphur
		Microscopic sulphur	sulphur
		Dikar	mancozeb* + dinocap
		Dithane DG	mancozeb
		Dithane M45	mancozeb
		Ferbam WDG	ferbam
		Gavel 75 DF	mancozeb* + zoxamide
M3	Phthalimide	Manzate DF	mancozeb
		Penncozeb 75 DF	mancozeb
		Polyram DF	metiram
		Ridomil Gold MZ	metalaxyl + mancozeb*
		Thiram	thiram
M4	Chloronitrile	Captan 80 WDG	captan
		Folpan 80 WDG	folpet
		Maestro 80 DF	captan
M6	Guanidines	Bravo 500	chlorothalonil
NC	Biological	Equal 65 WP	dodine
NC		Serenade Max	<i>Bacillus subtilis</i>
		MilStop	potassium bicarbonate

Note: Groups M1 through M6 are multisite inhibitors.

- Dagger nematodes spread tomato ringspot virus, which causes crumbly berries, mottled leaves and cane dieback.

On tree fruits:

- Root-lesion nematodes can be a major cause of orchard replant failures. They can cause a decline in vigour of existing peach and cherry orchards. These nematodes cause small brown lesions on the white lateral roots and kill the fine feeder roots. When lesions merge, the entire root system appears discoloured. Root lesions are frequently invaded by other root-rotting pathogens. Severely affected trees may lose all feeder roots; young replant trees may die. Existing trees lack uniformity.

Thresholds

Nematode populations above economic thresholds can significantly reduce yields. For economic thresholds see Table 2-9. *Thresholds for Nematodes on Fruit Crops.*

TABLE 2-9. Thresholds for Nematodes on Fruit Crops

Type of nematode	Control when levels reach
Root-lesion nematode	1,000/kg soil (exception: 500/kg soil on strawberries)
Root-knot	1,000/kg soil
Pin	5,000/kg soil
Dagger	100/kg soil
Bulb and stem	100/kg soil

- Nematode problems are most often found in sandy loam and sandy soils. Always sample these soils for nematode populations before planting fruit crops.
- Nematode problems are not usually found in clay or clay-loam soils. Sample these soils for nematodes before planting in replant sites or where susceptible crops have been recently grown.
- Also sample clay or clay-loam soils for dagger nematode on virus-susceptible grapes, raspberry or tree fruit and for pin nematode on rhubarb, rose and gladiolus.

Information on how to sample soil for nematodes and where to send the samples is found in Appendix D. *Diagnostic Services*, on page 212.

For more information, see OMAFRA Factsheet, *Sampling Soil and Roots for Plant Parasitic Nematodes*, Order No. 06-099.

Nematode control

Use a combination of the following methods to manage nematodes:

- rotate susceptible crops with non-host crops for several years
- plant nematode-suppressing cover crops
- incorporate nitrogenous soil amendments
- destroy residual crop roots
- plant resistant fruit cultivars
- control weeds
- use soil fumigation when necessary

Cover crops for nematode suppression:

Examples of nematode-suppressing cover crops:

- oilseed radish
- certain oriental mustards cultivars like Forage or Cutlass
- specific sorghum × sudan-grass hybrids
- African marigold cultivars like Crackerjack or Creole
- Canadian Forage Pearl Millet 101

These cover crops can reduce plant parasitic nematode populations. Not all cultivars reduce nematode populations, so choose the right variety. One or more years of nematode-suppressing cover crops may be required to successfully reduce nematodes below economic thresholds.

Cover crops suppress nematodes in different ways.

- Canadian Forage Pearl Millet 101 inhibits the ability of nematodes to reproduce in its root system.
- Certain cultivars of African marigolds produce a root exudate that kills nematodes in the soil.
- Nematode-suppressing cultivars of oilseed radish and certain oriental mustards produce isothiocyanate in their leaves, stems and petioles, which is toxic to the plant parasitic nematode when released into the soil. To be effective, these crops must be cut green and immediately incorporated into the soil.

Exclude cover crops such as clovers and buckwheat from berry and orchard rotations. These are

excellent hosts for root-lesion nematodes. If a cereal grain is to be used for one whole growing season, wheat or barley is the best choice. For more information, see *Characteristics of Cover Crops Grown in Ontario* at ontario.ca/crops.

Other cultural practices to reduce nematodes

Nematode populations can build on many weed species. A good weed control program is essential the year before planting fruit crops. Weeds should also be controlled when nematode-suppressing cover crops are grown.

Keep land fallow the year before planting to reduce nematode numbers. A disadvantage to fallow land is increased susceptibility to soil erosion.

In orchards, choose ground covers between the rows that do not support nematodes, such as annual or perennial ryegrass.

Fumigation

Pre-plant soil fumigation is the most effective method of controlling nematode problems. Fumigants can be broadcast over the whole field or applied only in rows where trees will be planted. Tree-row application, or the treatment of a 2–2.5 m strip centered on the row, is more economical.

Treat areas that harbour potential nematode problems before planting. Refer to Table 2-10, *Control of Nematodes and Related Problems in Strawberry and Raspberry Plantings in Mineral Soils*, on this page, and Table 2-11, *Control of Nematodes and Related Problems in Orchards on Mineral Soils*, on this page.

Application of fumigants before planting

Most fumigants are applied by shank injection using specialized application equipment. Vapam and Busan can also be applied to the soil surface and watered in. See the product label for application instructions.

- Fumigate in the fall when soil temperatures are above 4°C. Warmer temperatures (15°C and over) are preferred for more rapid fumigant dispersal in the soil.
- Land preparation is critical for effective fumigant application. Remove trash and old root systems. Work the soil to a depth of 25–30 cm and obtain good seedbed condition with regard to tillage and moisture.

- Seal the soil surface by packing or watering immediately after injection of the fumigant.
- Leave soil undisturbed until spring or, with fall planting, at least one week after injection of the fumigant. Colder soils (below 15°C) require longer periods from injection to aeration.
- Work the soil and aerate for about a week before planting. For fall planting, work the soil and aerate for two weeks before planting.
- Use high-quality planting stock, preferably grown in fumigated soil.
- Always read the product label.

For more information, see OMAFRA Factsheet, *Land Preparation: A Key to Successful Soil Fumigation*, Order No. 89-177.

TABLE 2-10. Control of Nematodes and Related Problems in Strawberry and Raspberry Plantings in Mineral Soils

To control	Material	Rate ¹ (L/ha)
Nematodes only	Telone II	170
	Busan 1020	470
Verticillium & nematodes	Telone C-17	200–380
	Vapam ²	470–900
	Busan 1020	935
	Chloropicrin 100	93–140 ³

¹ Use high rate for heavier soils, e.g. clay loams.

² Vapam is applied by shank injection or in irrigation water, i.e. chemigation. For the chemigation rate, refer to label.

³ Use high rate for strawberry runner production only.

TABLE 2-11. Control of Nematodes and Related Problems in Orchards on Mineral Soils

To Control	Material	Rate ¹ (L/ha)
Nematodes only	Telone II	200
	Busan 1020	470
Nematodes, diseases	Telone C-17	280
	Busan 1020	935
Nematodes, diseases, weeds	Vapam ²	470–900
	Busan 1020	935

¹ Use high rate for heavier soils, e.g. clay loams.

² Vapam is applied by shank injection or in irrigation water, i.e. chemigation. For the chemigation rate, refer to label.

CAUTION

Telone, Vapam, Chloropicrin and Busan are toxic. Read the label and follow instructions in regard to procedures for handling and application.

Always follow manufacturer's directions carefully with concern to dosage and methods of use. A suitable respirator and protective clothing, etc., must be worn by the applicator.

Fumigating single tree sites for replacement trees

When trees are replanted within an existing orchard, nematodes and diseases can be controlled in the planting hole using Vapam, or Busan 1020, before planting. Refer to the product label for application details and safety precautions.

Nematode suppression after planting: VYDATE L

Vydate L can be used to suppress nematodes after planting non-bearing apples and raspberries. Vydate L is less effective than pre-plant soil fumigation and does not control soil-borne disease.

Non-bearing apples (trees that will not bear fruit within 12 months of application)

Root-lesion nematode numbers can be reduced in non-bearing apple orchards, after planting, with oxamyl (Vydate L, = 240 g active oxamyl/L). For best results, apply a soil drench and one foliar application of Vydate. Refer to the product label for rates and precautions.

- Apply a soil-drench in spring when roots are actively growing and leaf growth begins on young whips and non-bearing trees. Mix the solution at 1.25 L Vydate/1,000 L of water and apply at 3.5–10 L of the solution per tree, in a circle approximately 1 m in diameter around the base of each tree. This will cover the root zone. Apply in warm weather, as Vydate is less effective when temperatures reach below 7°C. Do not apply to trees under water stress or not actively growing.
- When leaves have fully expanded and trees are actively growing, spray the foliage and repeat if necessary on a two to three week schedule for a total of three applications per season. Mix 4.1–8.2 L Vydate/1,000 L of water and apply no more than 9.35 L of Vydate/ha. Do not allow spray to drift onto trees in bloom. Do not apply to trees under water stress or not actively growing.

- Do not re-enter treated orchards for 48 hours.
- Sample the soil for nematodes in early September of the planting year to check on the need for further treatment.

Root absorption of Vydate L occurs during periods of rapid shoot growth in early spring. Foliar absorption occurs best in young, rapidly expanding foliage. Foliar sprays interfere with insect predators and are not recommended in orchards using integrated pest management.

Raspberries

- Use Vydate L to suppress root-lesion nematodes in raspberries. Make one application of Vydate L at 9.35 L/ha of treated soil area in the fall before October 31 as a soil drench over roots. Do not apply in the spring. To treat a 1.5 m wide strip, mix 1.4 L of Vydate L in 360 L of water and apply on 1,000 m of row. Only raspberry roots that are actively growing absorb Vydate L. Late application on dormant plants or when air temperature is below 7°C is less effective. Do not apply more than once a year. Do not re-enter treated fields for 48 hours.

CAUTION

Vydate L is very toxic to humans. Follow application instructions closely.

Vydate L is highly toxic to bees. Do not apply during the pink or bloom period.

Bird Control

For more information on bird control, see OMAFRA Factsheet, *Bird Control on Grape and Tender Fruit Farms*, Order No. 98-035.

Every year birds destroy large quantities of fruit in Ontario. Sweet cherries, grapes, blueberries and saskatoon berries are the crops most subject to attack but other fruit crops may also be damaged. The amount of loss due to birds depends on the cultivar, the time of season, location in the province, proximity to bush and hydro lines, and availability of other food sources. Losses range from relatively minor to a total crop loss. Actual losses are difficult to measure, since fruit that has disappeared is hard to account for. Pecking and puncturing damage are often as

great as actual losses from fruit consumed and can cause secondary problems with rot.

Controlling bird damage

Fruit becomes attractive to birds as it begins to colour. Birds are very selective and know where to find the most tasty, ripe fruit. Start controls early, 10–30 days prior to colouring of the fruit, depending upon the cultivar. An integrated approach is the best method of bird control. Use several control methods to provide a longer lasting effect. Using one method alone will not provide effective control compared to an integrated approach.

Location

Where you plant commercial fruit crops can be an important factor in bird control. Fruit crops planted near a wooded area are particularly susceptible to damage, because birds find shelter and nest sites close by.

Physical protection

The only completely effective control method is to cover the crops with net. This method may be economically feasible for some higher valued cultivars of grapes, cherries and highbush blueberries. However, nets are not the answer for every situation since they can be costly to purchase and install, and can be difficult to work around. There is considerable interest by growers to find simpler, cost-effective netting systems for fruit crops.

Shooting

Normally, shooting does not significantly reduce bird populations but it does frighten them out of the orchard. Laws protect robins and northern orioles, but special permits may be obtained to kill them if you can show they are causing damage.

For a permit, contact the enforcement co-ordinator, Canadian Wildlife Service, Environment Canada, at 905-336-4464.

Shells are also available with delayed explosions and/or sustained whistles that disorient and frighten the birds.

Propane-fired bird scaring cannons

Cannons are one of the most commonly used bird scaring devices. These devices cause birds to flee from the loud, unexpected gunshot-like sounds,

produced at random intervals. Move the cannons periodically to different locations in the orchard or vineyard. Birds quickly adjust their feeding habits if cannons are left in the same location throughout the harvest season.

A major drawback of these devices is the disruption to neighbours. Growers must recognize this and adjust the use of this equipment to minimize discomfort to neighbours. Most neighbours are sympathetic to the need for crop protection, but their sympathy ends if the equipment is not used properly.

- Fire cannons only during bird forage periods in daylight hours, generally accepted to be between 30 minutes before sunrise and 30 minutes after sunset. Check the local newspaper or radio for sunrise and sunset times in your area. Operation outside these times is not considered to be normal farm practice.
- Place cannons as far away from neighbours as possible and at least 122 m (400 feet) away from their houses.
- Monitor the equipment constantly to ensure it functions properly.

Electronic sound devices

This equipment emits electronic sounds that imitate distress or predator calls of different bird species or other types of sounds. The sound produced, although loud, is usually less objectionable to neighbours than propane-fired cannons.

- Operate electronic sound devices only during daylight hours.
- Move the equipment periodically for maximum effectiveness.

Chemical controls

There are currently no chemicals registered for use in Ontario to control birds in fruit crops. It is illegal to use unregistered chemicals.

Visual deterrents

Visual deterrents include: aluminum foil hung in trees, model hawks and other birds of prey, strips of yellow plastic hung across vineyards, vibrating plastic strips, scarecrows, mirrors, kites and scare-eye balloons. Visual deterrents move with the wind, produce noise and make reflections.

Falconry

Trained falcons and hawks have been used successfully for many years. Experienced falconers are needed to fly the birds. Availability, cost and time are major drawbacks for fruit growers.

Regardless of the bird control method used, follow all local, provincial and federal laws that govern the slaughter of birds or the use of sound.

Deer and Rodent Control in Orchards

For more information on all aspects of deer and rodent control, see OMAFRA Factsheet, *Rodent and Deer Control in Orchards*, Order No. 98-023.

Control of rodents and deer is most effective when it is part of a season-long management strategy, which includes good sanitation, cultural and chemical control methods.

Deer control

Deer removal permit program

You must have a permit to shoot deer in defense of property. Contact the local Ministry of Natural Resources (MNR) office for an evaluation and action plan. Action depends on the severity of damage, the level of previous control attempts and a reasonable expectation of problem deer control.

The MNR area supervisor or enforcement supervisor issues permits to farmers or their agents in order to kill white-tail deer in defense of property.

Before a deer removal permit is issued, these conditions must be satisfied:

- A written report must be filed, which reflects the extent of damage in percentage of crop and associated dollar value. The evaluator must consider the damage to be economically significant.
- The farmer has made reasonable attempts to control deer through the use of deterrents, modified farm management practices and has permitted licensed deer hunters on the property during open season, if any. This should be documented and kept with the deer removal permit file.
- Appropriate arrangements for the disposal of the carcass(es) have been made.

Mouse and vole control in orchards

Use a wide weed-free strip in the tree row or under individual trees, coupled with regular close mowing of orchard ground cover to help discourage mice.

- Remove straw, trash, sod, etc. from around the base of the tree for at least 60 cm from the trunk.
- Encourage predation by cats, foxes and birds of prey, especially red-tailed hawks, kestrels and great horned owls, which all help to reduce mouse populations.

Use a guard around the trunk of all newly planted trees. A number of commercial tree guards are available. Two of the most common are spiral plastic and galvanized wire mesh. Bury the bottom of the guard in the soil 5 cm deep, or preferably, in a mound of fine crushed stone or sharp cinders. Tree guards require regular maintenance.

- Check tree guards each fall to see they are mouse-proof and free of trash.
- Ensure tree guards do not interfere with root development as the tree grows.
- Spiral guards left in place too long can interfere with bark development and should be removed before this occurs.

Bait for mouse and vole control in orchards

Baits are most effective if dropped apples are picked up and removed from the orchard. Before the grass falls over and the ground is covered with snow, broadcast bait over the floor of the orchard. Baits are best applied on bright days with no rain expected for several days.

Several commercial formulations of bait are available for orchard use. Consult the label before application and obey all safety instructions.

- **Zinc phosphide-treated baits:** Several products are available. Application rates are between 4.5–9 kg/ha, depending on the severity of infestation. If further mouse activity is detected, repeat the treatment when rain is not expected.
- **Diphacinone (Ramik Brown):** Apply twice, 11 kg/ha, 20–40 days apart. (Total application rate 22 kg/ha).
- **Chlorophacinone (Rozol):** Apply 12.5 kg/ha and repeat in 20–60 days where infestation is high.

Bait stations help control mice longer than broadcast treatment. Bait stations also help prevent non-target mammals from feeding on the bait. Pieces of board or tin cans with one end removed can be used for bait stations. Place the bait under the board or in the can with the can on its side. The “inverted T” bait station made of 1½ inch ABS pipe is the most effective bait station available. In this station several tablespoons of bait are placed in the neck, which is then capped to protect the bait from the elements. Set up bait stations at a rate of approximately 25/ha (10/acre).

Baits are poisonous to humans, domestic animals and wildlife.

- Store the bait away from children, irresponsible persons and animals.
- Wear chemical-resistant gloves and wash after you handle poison baits.
- Avoid inhalation of dust or fumes.
- Destroy empty containers safely.
- Keep children, pets and domestic animals away from treated areas.
- Where possible, remove mouse bodies and bury or dispose of them in a safe manner.

Controlling rabbits

Wrapping young trees

Wrap sacking around the top and the trunk above the mouse guard to protect young trees from rabbits. Tie the wrapped tree securely to a strong stake or steel fence post to prevent snow and ice breaking the tree over. Mouse guards generally do not give protection against rabbits when the snow is deep.

Repellents

Rabbits do not like to feed on the trunks of young trees if the trees have been treated with thiram. There are a number of commercial mixtures available, some of which mix white latex paint with thiram. Be sure to treat the tree as high as rabbits can reach when they stand on deep snow.

For more information about the application of paint with thiram, refer to *Control of Southwest Injury on Fruit Trees*, on this page.

Repairing damage by mice and rabbits

Carry out regular inspection throughout the winter to check for injury. Mice often work just below the surface of the snow or in the litter. If a tree has been wholly or partially girdled, cover the wound with grafting compound or wound dressing promptly or before it dries out.

Before the buds swell in the early spring, secure scions that are long enough to bridge the wound. For more details, see OMAFRA Factsheet, *Repair Grafting*, Order No. 98-003. Store scions in damp sand or sawdust in a cool place or preferably, refrigerated conditions. If the wound extends for more than one quarter of the circumference of the trunk, bridge graft in the manner described in *Repair Grafting*. Graft when the bark slips readily from the wood, usually about bloom. Repair grafting is not practical on trees with a diameter less than 10 cm. Instead, replace small trees.

Control of Southwest Injury on Fruit Trees

Southwest injury, or winter sunscald, occurs in the winter and is especially severe when cold, sunny days are followed by cold, still nights. This phenomenon can occur in apple, peach, pear, cherry, plum, apricot and tree nut orchards. Injuries are usually confined to the south and southwest sides of the trunks and main scaffold branches. On sunny days these tissues become considerably warmer than the surrounding air and at night they cool rapidly. Under these conditions, freezing of the bark may occur. This injury usually affects large portions of the bark tissue that become brown and eventually slough off as healing occurs beneath.

In stone fruit orchards, these injuries provide ideal sites for infection by peach canker or other canker diseases. The combined effect of southwest injury and peach canker greatly reduces the productive life of affected trees.

Paint the trunk, crotches and lower parts of main scaffold branches with exterior white latex paint to minimize southwest injury. The white paint reduces the damage by reflecting direct sunlight on exposed tissue. This helps to prevent rapid warming on sunny days when air temperatures are below freezing.

Do not use oil-based paints or latex paints that contain some oil. These products contain toxic materials that may injure or kill fruit trees.

- October is the best time to apply the paint. Best results are obtained when trees are painted on days when the temperature is above 10°C and when spray will dry rapidly.
- Apply the paint by brush or by spray. If you choose spray, use 1–2 L of water/4.5 L of paint, depending on the thickness of the paint and the air pressure available.
- On young trees, paint the whole trunk. Only the south and southwest sides of older trees require paint. The whiter the bark after you paint, the greater the protection. Better quality paints are more durable.
- On young trees, injury from rodents may be a greater problem than southwest injury. To obtain protection from both problems, use commercially available thiram-latex mixtures, which reflect sunlight and act as a taste repellent for rodents.
- Do not use the thiram-latex mixture if you plan to use a fall Bordeaux spray program. The thiram reacts with the Bordeaux spray, changing the colour of the paint from white to brown and reducing its effectiveness as a heat reflector. The Bordeaux spray does not affect trees painted with latex only and can be used when thiram is excluded from the mixture.

Use of Copper Products on Fruit Crops

Chemical characteristics of copper fungicides

Copper mixtures have long been recognized as having fungicidal properties. Historically, Bordeaux mixture was an important copper fungicide. It was made by mixing bluestone, which is a raw form of copper sulphate and hydrated lime.

Free copper ions provide most of the activity copper mixtures have on fungal and bacterial diseases. However, free copper can also be toxic to plants, as it can cause burned leaves and russeted or scarred fruit. Bordeaux mixtures are considered unsafe after “1/4 inch green” on most fruit crops.

“Fixed copper” collectively describes a group of copper formulations that contain complex copper sulfates, copper oxychlorides, and copper oxides.

Fixed copper compounds are:

- easier to handle than Bordeaux
- equal in efficacy to Bordeaux, except they do not adhere or persist as well
- generally less phytotoxic and less corrosive than Bordeaux

These new copper formulations have a small particle size and have added materials to improve spreading and sticking qualities. Always check the product label for use patterns, rates and timings for each crop.

Procedures to tank-mix copper formulations and lime

Some fixed copper labels suggest you mix the copper with lime. If you have problems mixing fixed coppers with lime, follow these instructions:

1. Start water flow into the spray tank.
2. When the tank is about one-third full and the mechanical agitator is on, wash the powdered copper product into the tank through a screen with water from the supply hose. Use a wooden spoon to help work the copper product through the screen. The screen prevents large granules of copper, which form if opened product gets wet then dries, from getting into the tank. Premix the copper product with hot water to help the product dissolve. Put all of the copper in the tank by the time the tank is two-thirds full.
3. Wash the lime mixture through the screen into the copper solution in the tank. Use hydrated or builder's lime. Pre-soaking the lime before you add it to the copper solution in the tank may be preferable to washing powdered lime directly through the screen into the tank. Use a lot of water from the supply hose to dilute the lime as much as possible before it meets the copper solution.
4. Keep the agitator running continuously and apply the copper mixture immediately. Do not allow the mixture to settle out.

Registration status and availability of copper fungicide products

It is important to use only copper products that have a federal label with a Pest Control Product (PCP) number. The PCP number indicates the product is

approved as a crop protection product for application on agricultural crops. Presently, there are five copper products with PCP numbers and a federal registration. For a summary of labeled products and crop uses consult Table 2-12. *Copper Products for Use on Fruit Crops in Ontario.*

TABLE 2-12. Copper Products for Use on Fruit Crops in Ontario*

Category	Registered Copper Products				
Product Name	Copper 53 W	Basicop	Guardsman Copper Oxychloride 50	Copper Spray	Triangular Brand Copper Sulfate
PCP Registration No.	09934	19003	13245	19146	24034
Ontario Classification	Schedule 2	Schedule 3	Schedule 2	Schedule 3	Schedule 3
Active Ingredient	Copper from tribasic copper sulfate 53%	Copper in basic copper sulfate 53% by weight	Copper from copper oxychloride 50%	Copper from copper oxychloride 50%	Cupric sulphate pentahydrate (metallic copper 25.2%)
APPLES registration status rate of formulated copper ¹ rate of hydrated lime	✓ 1 kg 6 kg	✓ 1 kg 6 kg	✗	✓ 4 kg no lime required	✓ 2 kg 6 kg
APRICOTS registration status rate of formulated copper ¹ rate of hydrated lime	✗	✗	✗	✗	✗
BLACKBERRIES registration status rate of formulated copper ¹ rate of hydrated lime	✗	✗	✗	✗	✗
BLUEBERRIES (highbush) registration status rate of formulated copper ¹ rate of hydrated lime	✗	✗	✓ 2–4 kg no lime required	✓ 2–4 kg no lime required	✗
CURRANTS registration status rate of formulated copper ¹ rate of hydrated lime	✓ 3–5 kg 4 kg	✓ 3–5.5 kg 4 kg	✗	✗	✗
FILBERTS HAZELNUTS registration status rate of formulated copper rate of hydrated lime	✗	✗	✓ 3–9 kg/ha no lime required	✓ 3–9 kg/ha no lime required	✗
GOOSEBERRIES registration status rate of formulated copper ¹ rate of hydrated lime	✓ 3–5 kg 4 kg	✓ 3–5.5 kg 4 kg	✗	✗	✗

* List of copper products with federal registration and classified for sale and use in Ontario, as of November, 2007.

¹ Rate is expressed kg/1,000 L of water unless otherwise stated. Also check label for maximum rate/ha.

² Do not use on French hybrids or vinifera varieties.

³ Do not use on Seibel varieties.

✓ registered in Ontario.

✗ not registered.

TABLE 2-12. Copper Products for Use on Fruit Crops in Ontario* (cont'd)

Category	Registered Copper Products				
Product Name	Copper 53 W	Basicop	Guardsman Copper Oxychloride 50	Copper Spray	Triangular Brand Copper Sulfate
PCP Registration No.	09934	19003	13245	19146	24034
Ontario Classification	Schedule 2	Schedule 3	Schedule 2	Schedule 3	Schedule 3
Active Ingredient	Copper from tribasic copper sulfate 53%	Copper in basic copper sulfate 53% by weight	Copper from copper oxychloride 50%	Copper from copper oxychloride 50%	Cupric sulphate pentahydrate (metallic copper 25.2%)
GRAPES					
registration status	✓	✓	✓	✓	✗
rate of formulated copper ¹	3 kg ²	3 kg	3 kg ³	3 kg ³	
rate of hydrated lime	6 kg	6 kg	6 kg	6 kg	
PEACHES					
registration status	✓	✓	✓	✓	✗
rate of formulated copper ¹	4 kg	4 kg	2 kg	2 kg	
rate of hydrated lime	no lime required	no lime required	no lime required	no lime required	
PEARS					
registration status	✓	✓	✗	✗	✓
rate of formulated copper ¹	1 kg	1 kg			2 kg
rate of hydrated lime	6 kg	6 kg			6 kg
PLUMS					
registration status	✗	✗	✗	✗	✗
rate of formulated copper ¹					
rate of hydrated lime					
RASPBERRIES					
registration status	✓	✓	✓	✓	✗
rate of formulated copper	4–5 kg/ha	4–5 kg/ha	2.5–3.0 kg/ha	2.5–3.0 kg/ha	
rate of hydrated lime	no lime required	no lime required	no lime required	no lime required	
SOUR CHERRIES					
registration status	✓	✓	✓	✓	✗
rate of formulated copper ¹	2 kg	2 kg	2 kg	2 kg	
rate of hydrated lime	4 kg	no lime required	4 kg	4 kg	
SWEET CHERRIES					
registration status	✗	✗	✓	✗	✗
rate of formulated copper ¹			6–9 kg/ha		
rate of hydrated lime			no lime required		
STRAWBERRIES					
registration status	✓	✓	✗	✗	✗
rate of formulated copper	2.5–3.8 kg/ha	2.3–3.8 kg/ha			
rate of hydrated lime	no lime required	no lime required			
WALNUTS					
registration status	✗	✗	✗	✓	✗
rate of formulated copper				4 kg/ha	
rate of hydrated lime				no lime required	

* List of copper products with federal registration and classified for sale and use in Ontario, as of November, 2007.

¹ Rate is expressed kg/1,000 L of water unless otherwise stated. Also check label for maximum rate/ha.² Do not use on French hybrids or vinifera varieties.³ Do not use on Seibel varieties.

✓ registered in Ontario.

✗ not registered.

3. Soil Management, Fertilizer Use and Crop Nutrition

For a complete guide to soil fertility, consult OMAFRA Publication 611, *Soil Fertility Handbook*.

Crop nutrition is an important component in the production of high yield, top quality fruit crops. To be taken up by the crop roots, nutrients must be dissolved in the soil water. They then enter the roots along with the water that becomes part of the transpiration stream. Therefore, the most efficient use of fertilizer is intricately tied to soil and water management. The development of a sound soil fertility program begins with the assessment of nutrient needs.

Assessing Nutrient Needs

There are three ways to assess soil and crop fertility:

- soil-testing
- plant tissue analysis
- visual deficiency symptoms

These are not interchangeable methods. For perennial crops, all three methods are needed to assess and monitor the crop's nutritional status.

Soil testing

A soil test using laboratory methodology suited to the particular soil type is the best measure of plant-available nutrients. OMAFRA accredits specific laboratory methods that are suited to Ontario soils and accredits labs that have proven their ability to perform these tests accurately. See Table 3-1. *OMAFRA-Accredited Soil Tests*. A test for soil organic matter can be useful but is not an accredited test. OMAFRA-accredited soil tests are not available for boron, copper, iron or molybdenum. Tissue analysis of these micronutrients is a better indicator of the crop nutrient status.

When to sample

Always take soil samples before you plant fruit crops. Where pH adjustments may be necessary, sample two years before planting so that pH adjustments can be made. After establishment, sample each field

TABLE 3-1. OMAFRA-Accredited Soil Tests

See Appendix C. *Accredited Soil-Testing Laboratories in Ontario*, on page 211, for a list of accredited labs in Ontario.

Materials	What is Analyzed
Soils for field-grown crops, commercial turf, etc.	plant-available phosphorus, potassium, magnesium, zinc and manganese; pH; lime requirement
Greenhouse media	plant-available nitrogen, phosphorus, potassium, calcium, magnesium; pH; total salts
Nutrient solutions, water	plant-available nitrogen, phosphorus, potassium, calcium, magnesium; pH; total salts; sulphates; chlorides

once every two or three years. In sandy soils, consider checking soil potassium levels more frequently.

Soils may be sampled in the fall or in the summer. Sample at the same time each year for more consistent sample results. Late summer or fall sampling is ideal for fields to be planted in the spring. Regardless of when you sample, allow time to mail the samples and receive your report.

Taking a soil sample

Soil test report accuracy and the recommendations that result depend on the proper collection, preparation and submission of a soil sample. To take a soil sample you will need:

- soil probe or a shovel
- clean plastic pail (avoid galvanized metal pails, which will contaminate the sample for micronutrient analysis, particularly zinc)
- sample bags and boxes, usually available from the soil laboratory
- a pen or marker

Sample each field or individually managed unit separately. Separate large fields, or fields with considerable variation, into smaller sections. Each sample should represent a field or field section with similar

soil texture, topography, organic matter and crop history.

Micronutrient deficiencies most often occur in small patches in fields. In these cases, soil or plant samples taken from the entire field are unlikely to show a problem. Sample problem areas separately. When you sample a problem area, be sure to take a comparison sample from an adjacent area without symptoms.

For a basic test, collect soil cores to a depth of 15 cm. Nitrogen samples are taken to a depth of 30 cm. Take at least 20 soil cores for fields up to 5 ha in size. Take proportionately more cores for fields larger than 5 ha. The more cores taken, the more likely the soil sample is to provide an accurate measure of the fertility in the field. One sample should not represent more than 10 ha.

Travel the area sampled in a zigzag pattern to provide a good variety of sample sites. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or areas where lime, manure, compost or crop residues have been piled.

Break up lumps and mix the soil thoroughly, since only about 2 mL of soil from the sample will be used for each analysis. Fill a clean plastic bag with approximately 500 g of soil and place it into the box. Be sure to clearly mark the sample with all of the necessary information (i.e. sample number, farm name, date, etc.).

Interpreting Soil Test Results

The OMAFRA-accredited soil-testing program provides recommendations for nitrogen, phosphate, potash, magnesium, zinc and manganese fertilizer. It also gives recommendations for the amount and type of lime to be applied, if required. These recommendations are specific to the future crop to be grown, specified on the lab submission form. Crop specific details found on:

Apples	page 44
Berry crops	page 89
Grapes	page 126
Tender fruit	page 143

These recommendations can produce the highest economic yields when accompanied by good or above-average crop management.

On a basic soil test report, each nutrient is given a numerical value (in parts per million (ppm) or milligrams per litre (mg/L) of soil), a letter rating and a

fertilizer recommendation (usually kg/ha or lb/ac). The letter rating of the nutrient indicates the likelihood of a profitable response to applied nutrient for the specified crop. This letter rating system is explained in Table 3-2. *Soil Test Nutrient Ratings*.

TABLE 3-2. Soil Test Nutrient Ratings

Response Category	Probability of profitable response to applied nutrients
High Response (HR)	High (most of the cases)
Medium Response (MR)	Medium (about half the cases)
Low Response (LR)	Low (few of the cases)
Rare Response (RR)	Rare (very few of the cases)
No or Negative Response (NR)*	Not profitable to apply nutrients

A fertilizer recommendation depends on the crop to be grown and is affected by applying manure or plowing down legume sod. Recommended fertilizer rates, especially for nitrogen and phosphorus, should be adjusted if manure and cover crops are used. This information is essential for an optimum fertilizer recommendation.

There are several methods for developing fertilizer recommendations from soil test results. The pros and cons of each are described below.

OMAFRA-Accredited Recommendations

The OMAFRA-accredited program is based on field trials that determine the maximum economic rate of each nutrient, based on the soil test result. This amount is most likely to maximize profit in the current year. Applying nutrients at OMAFRA-recommended rates will maintain or gradually increase soil fertility. As a soil test value increases, applying more of that nutrient produces lower yield response per unit of fertilizer. The soil test ratings of low response (LR), rare response (RR), or no response (NR) indicate the probability of an economic response to adding more of that nutrient. For some fruit crops, a specific nutrient recommendation may be based on enhancing crop quality rather than the maximum economic yield.

Crop Removal Recommendations

Crop removal recommendations select fertilizer rates to replace the amount of nutrients removed in the harvested crop portion. This system does not account for nutrients stored in perennial tissue or nutrients supplied by the inherent fertility of the soil. As a result, the rates recommended for phosphorus and potassium are often uneconomical on fertile

soils. On soils with low fertility, too little fertilizer may be recommended. Crop removal of phosphorus (P) and potassium (K) is not closely related to P and K fertilizer requirements.

Build-up and Maintenance Recommendations

Build-up and maintenance recommendations aim to meet annual nutrient requirements and improve the soil test value. For soils testing low response (LR), rare response (RR), or no response (NR), fertilizer may be recommended to maintain those soil test levels despite the low, or zero, probability of an economical response. High levels of some nutrients may interfere with the uptake of others and cause yield reductions. There is no advantage in maintaining the soil test levels in the RR or NR ratings. Most crops can be grown on these soils for several years before fertilizer is required.

Base Saturation Ratio Recommendations

Some soil reports use base saturation ratios to develop recommendations for potassium, calcium and magnesium. This assumes there is an ideal ratio of these nutrients and recommends fertilizer rates to achieve it. The proportion of one nutrient to another is assumed to be an indication of its availability. While there is interaction among soil test levels of these nutrients in terms of crop yield, the mechanism by which it occurs is to induce a deficiency or toxicity in the plant. If the soil test level maintains the crop tissue in the sufficiency range, interactions are highly unlikely to occur. Crops can grow at a wide range of potassium-calcium-magnesium ratios. Many Ontario soils are naturally high in calcium and magnesium. As a result, the recommended rate of potassium is often high and uneconomical. Striving to meet an exact ratio is typically expensive and has little, if any, effect on crop yield.

Plant tissue analysis

Tissue analysis measures the nutrient concentration in plant tissue. For perennial crops, tissue analysis is an important addition to soil tests. Tissue analysis results are compared against established normal ranges for the crop and indicate whether a specific nutrient is deficient. The tissue test can indicate whether the soil is supplying adequate nutrients for optimum growth. If soil levels are known to be adequate, tissue tests may indicate nutrient uptake is being restricted by other problems.

Plant analysis is particularly useful for the evaluation of phosphorus, potassium, magnesium and

Soil tests from other laboratories

Rely only on OMAFRA-accredited soil tests to provide accurate fertilizer recommendations.

Be certain that the service you use is accredited. To be accredited, a laboratory must use OMAFRA-approved testing procedures to demonstrate acceptable analytical precision and accuracy and must also provide the OMAFRA fertilizer recommendations. Ensure that you ask for the OMAFRA fertilizer recommendations. Soil tests for nutrient management plans must be completed at OMAFRA-accredited labs.

Soil tests for exchange capacity, aluminum and copper are not accredited by OMAFRA because they have not been found to contribute to better fertilizer recommendations.

manganese. It is the main tool for assessing the status of boron, copper, iron and molybdenum, as there is no reliable soil test for these micronutrients. Tissue analysis has not been as reliable for nitrogen and zinc.

Sampling

The time a sample is collected can have a major impact on the results of plant analysis. The concentrations of some nutrients vary considerably with the age and date of the sampled tissue. Results are difficult to interpret if samples are taken at times other than what is recommended for the crop.

- Collect tissue samples into labelled paper bags. Plant tissues will rot if stored in plastic bags.
- Avoid collecting damaged leaves or leaves from plants that appear abnormal.
- If variable areas are large enough to fertilize separately, they should be sampled separately.
- Avoid contamination of the sample with soil. Even a small amount of soil will cause the results to be invalid, especially for micronutrients.
- Plants suspected of nutrient deficiency should be sampled as soon as a problem appears. Take tissue samples from a problem area and submit a separate sample from an adjacent, non-affected part of the field. Also collect and submit a soil sample from both affected and non-affected areas to aid diagnosis.

TABLE 3-3. Sampling Methods for Tissue Analysis of Fruit Crops

Crop	Stage of growth/timing	Plant part sampled	Approximate number to collect
Apple	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height from all sides of tree	10 leaves from 10 representative trees
Blueberry, Highbush	Late July–early August	Mature mid-shoot leaves of current year growth	100 leaves throughout sampling area
Cherry, Montmorency	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height	10 leaves from 10 representative trees
Grapes	Early September	Petioles from mature leaves of fruiting canes. Remove from leaf immediately	75–200 depending on variety size
Peach	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height	10 leaves from 10 representative trees
Pear	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height	10 leaves from 10 representative trees
Raspberry	Late July	Fully expanded leaves from fruiting cane	100 leaves throughout sampling area
Strawberry	Fruiting – June Non fruiting – early August	Fully expanded, recently matured leaf blade – discard petiole immediately	50 blades throughout sampling area

Sample Preparation

Fresh plant samples should be delivered directly to the laboratory. If they cannot be delivered immediately, they should be dried to prevent spoilage. Samples may be dried in the sun or in an oven at 65°C or less.

Take precautions to prevent contamination with dust or soil. Avoid contact of samples with brass, copper or galvanized (zinc-coated) metal.

Plant analyses may be obtained from several laboratories in Ontario, see Appendix C, *Accredited Soil-Testing Laboratories in Ontario*, on page 211. Tissue analysis is not part of the OMAFRA accreditation program. However, OMAFRA-accredited labs have the necessary skills and equipment to perform accurate tissue analysis.

Interpretation

Tissue analysis has limitations and expert help is sometimes needed to interpret the results. Tissue analysis does not typically indicate how much fertilizer is required to correct a deficiency or even whether a deficiency is related to fertility problems. Tissue test results in the deficiency range may also be due to factors such as climate, pest pressure or disease, and therefore should be used in conjunction with a soil-testing program. Table 3-4, *Nutrient Concentrations Sufficiency Ranges for Fruit Crops*, on page 31, shows the range of tissue nutrient

concentration that should result in optimum productivity for the various fruit crops.

Visual deficiency symptoms

Leaf symptoms can help evaluate some nutrient deficiencies, but have limitations. By the time deficiency symptoms are visible, yield losses may already have incurred. Visual deficiency symptoms are easily confused with other production problems such as pesticide injury, leaf and root diseases, nematodes, insect damage, compaction or air pollution. Suspected visual deficiencies should always be confirmed by tissue analysis. Specific nutrient deficiency symptoms are described for apples on page 44, for berry crops on page 89, for grapes on page 126 and for tender fruits on page 143.

Soil Organic Matter

Soil organic matter helps maintain soil structure, enhances soil moisture holding capacity, increases the ability of the soil to hold nutrients and improves drainage. Adequate soil organic matter levels can help maintain crop yields and long-term plant health, especially in adverse weather conditions. Many horticultural soils are light-textured and frequently cultivated. The maintenance of organic matter levels in these soils is a challenge.

To ensure long-term productivity of fruit crops, assess the soil quality of each field before planting and take steps to maintain or improve it. For more

TABLE 3-4. Nutrient Concentration Sufficiency Ranges for Fruit Crops

Crop	N	P	K	Ca	Mg	Fe	B	Cu	Zn	Mn
	%					ppm				
Apple ¹										
Delicious, Crispin	2.2-2.7	0.15-0.40	1.4-2.2	0.8-1.5	0.25-0.40	25-200	20-60		15-100	20-200
Empire, Spy	2.1-2.6	0.15-0.40	1.3-2.1	0.7-1.5	0.25-0.40	25-200	20-60		15-100	20-200
McIntosh, others	2.0-2.5	0.15-0.40	1.2-2.0	0.8-1.5	0.25-0.40	25-200	20-60		15-100	20-200
Berry Crops										
Blueberry, Highbush	1.7-2.3	0.15-0.40	0.36-0.7	0.3-0.8	0.12-0.30	30-100	15-50		10-100	150-500
Raspberry	2.0-3.5	0.20-0.50	1.0-2.0	0.8-2.5	0.25-0.50	25-200	20-60	5-20	15-100	20-200
Strawberry	2.0-3.0	0.20-0.50	1.5-2.5	0.5-1.5	0.25-0.50	25-200	20-60		15-100	20-200
Grapes (petioles)										
Vinifera	0.8-1.4	0.15-0.40	1.2-2.3	1.0-3.0	0.6-1.50	15-100	20-60		15-100	20-200
Fredonia	0.6-1.2	0.15-0.40	0.8-1.8	1.0-3.0	0.6-1.50	15-100	20-60		15-100	20-200
Other	0.7-1.3	0.15-0.40	1.0-2.0	1.0-3.0	0.6-1.50	15-100	20-60		15-100	20-200
Tender Fruit										
Peach	3.4-4.1	0.15-0.40	2.3-3.5	1.0-2.5	0.35-0.60	25-200	20-60		15-100	20-200
Pear	2.0-2.6	0.15-0.40	1.2-2.0	1.0-2.0	0.25-0.50	25-200	20-60		15-100	20-200
Plum	2.4-3.2	0.15-0.40	1.5-3.0	1.0-2.5	0.35-0.65	25-200	20-60		15-100	20-200
Cherry (Montmorency)	2.2-3.0	0.15-0.40	1.3-2.5	1.0-2.5	0.35-0.65	25-200	20-60		15-100	20-200
¹ Leaf N should be 0.2% higher for apple trees on M.9 or M.26 rootstocks and for all non-bearing trees.										

¹ Leaf N should be 0.2% higher for apple trees on M.9 or M.26 rootstocks and for all non-bearing trees.

information, see OMAFRA Publication 611, *Soil Fertility Handbook*.

TABLE 3-5. Optimum Soil Organic Matter Contents for a Range of Soil Types

Soil Type	Optimum % Organic Matter
Sandy soils	2-4 +
Sandy loam soils	3-4 +
Loam soils	4-5 +
Clay loam soils	4-5 +
Clay soils	4-6 +

Source: The Canada-Ontario Environmental Farm Plan Program workbook 3rd ed, 2004.

Soil pH and Liming

The soil's pH is a measure of its acidity or alkalinity. The pH scale ranges from 0 to 14. The pH is a measure of the hydrogen ion concentration. A pH value of 7.0 is neutral. Values below 7.0 are acidic.

Those above 7.0 are alkaline, also called basic. On mineral soils, most fruit crops grow well in a soil pH range from 6.0 to 7.5. Blueberries require a range of 4.2 to 5.0. Maintenance of a soil within the appropriate pH range is important. Many crop nutrients, especially micronutrients, become less available at a soil pH above or below the ideal range. Some ions, such as aluminium become toxic at low pH.

Raising pH

Soil pH is increased through the broadcast and incorporation of ground limestone into the soil. The amount of lime needed is determined by the soil test results. Table 3-6, *Soil pH at which Lime is Recommended for Ontario Field-Grown Crops*, on page 32, shows pH values below which lime is recommended and the target soil pH to which soils should be limed. In Ontario, most crops grow quite well at pH values higher than the target pH for which lime is recommended.

TABLE 3-6. Soil pH at which Lime is Recommended for Ontario Field-Grown Crops

	Soil pH below which lime is recommended	Target soil pH
Coarse and Medium Textured Mineral Soils (sands, sandy loams, loams and silt loams)		
All crops not listed below	6.1	6.5
Corn, soybeans, winter rye, grass hay and pasture, turf, tobacco, established tree fruits and grapes	5.6	6.0
Potatoes	5.1	5.5
Blueberry, cranberry, rhododendron, azalea	No lime recommended	
Fine Textured Mineral Soils (clays and clay loams)		
Alfalfa, cole crops, rutabagas	6.1	6.5
All crops not listed above or below	5.6	6.0
Corn, rye, grass hay and pasture, tobacco, established tree fruits and grapes, potatoes	5.1	5.5
Blueberry, cranberry, rhododendron, azalea	No lime recommended	
Organic Soils (peats and mucks)		
All crops not listed below	5.1	5.5
Blueberry, cranberry, rhododendron, azalea	No lime recommended	

Buffer pH

Different soils with the same pH value will require different amounts of lime to bring the pH to a particular level, depending on the clay and organic matter content of each soil.

- The soil pH is used to determine which soils need to be limed.
- On soils needing lime an additional analysis of the buffer pH is used to determine the amount of lime required.

For soils needing lime (based on soil pH), use Table 3-7, *Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH*, to determine the amount of lime required to reach the target soil pH.

TABLE 3-7. Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH

Ground limestone required – tonne/ha (based on Agricultural Index of 75)				
Buffer pH	Target soil pH = 7.0 ¹	Target soil pH = 6.5 ²	Target soil pH = 6.0 ³	Target soil pH = 5.5 ⁴
7.0	2	2	1	1
6.9	3	2	1	1
6.8	3	2	1	1
6.7	4	2	2	1
6.6	5	3	2	1
6.5	6	3	2	1
6.4	7	4	3	2
6.3	8	5	3	2
6.2	10	6	4	2
6.1	11	7	5	2
6.0	13	9	6	3
5.9	14	10	7	4
5.8	16	12	8	4
5.7	18	13	9	5
5.6	20	15	11	6
5.5	20	17	12	8
5.4	20	19	14	9
5.3	20	20	15	10
5.2	20	20	17	11
5.1	20	20	19	13
5.0	20	20	20	15
4.9	20	20	20	16
4.8	20	20	20	18
4.7	20	20	20	20
4.6	20	20	20	20

¹ Liming to pH 7.0 is recommended only for club-root control on cole crops.

² Add lime if soil pH is below 6.1.

³ Add lime if soil pH is below 5.6.

⁴ Add lime if soil pH is below 5.1.

The lime requirements listed in Table 3.7 are based on the equations below and rounded to the nearest tonne/ha. More exact requirements to adjust soil pH to 7.0 may be calculated from the equations in Table 3-8, *Calculation of Lime Required Using Buffer pH and Target pH*, on page 33.

TABLE 3-8. Calculation of Lime Required Using Buffer pH and Target pH

Target soil pH	Equation*
7.0	Lime (tonne/ha) = $334.5 - 90.79 \text{ pH}_b^{**} + 6.19 \text{ pH}_b^2$
6.5	Lime (tonne/ha) = $291.6 - 80.99 \text{ pH}_b + 5.64 \text{ pH}_b^2$
6.0	Lime (tonne/ha) = $255.4 - 73.15 \text{ pH}_b + 5.26 \text{ pH}_b^2$
5.5	Lime (tonne/ha) = $37.7 - 5.75 \text{ pH}_b$
* Based on lime with an agricultural index of 75.	
** pH_b = Buffer pH.	

Raising the soil pH with limestone

The application of either calcitic or dolomitic limestone can be used to raise soil pH. Calcitic limestone consists largely of calcium carbonate, while dolomitic limestone is a mixture of both calcium and magnesium carbonates. The carbonate in the limestone neutralizes the soil acidity.

Use dolomitic limestone on soils with a magnesium soil test of 100 ppm or less. It is particularly important to use dolomitic limestone when the level of potassium is high because high potassium levels make magnesium deficiency more likely. Either calcitic or dolomitic limestone can be used when magnesium test results are greater than 100 ppm and potassium levels are below 250 ppm.

Limestone varies in its effectiveness for raising soil pH depending on its neutralizing value and its particle size.

Neutralizing value is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. It is expressed as a percentage of the neutralizing value of pure calcium carbonate. Limestone that will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone, the higher its neutralizing value.

Fineness rating or particle size also affects the neutralizing value of limestone. The higher the fineness rating, the more rapidly the limestone raises the soil pH.

The agricultural index

The agricultural index combines the neutralizing value and the fineness rating of a limestone. It provides a way to compare different limestone sources. Limestone with a high agricultural index is applied

at a lower rate than limestone with a low index. The higher the agricultural index, the more valuable the limestone. A limestone's agricultural index is determined by the following formula:

$$\text{The agricultural index} = \frac{\text{neutralizing value} \times \text{fineness rating}}{100}$$

Limestone recommendations from the OMAFRA-accredited soil tests are based on limestone with an agricultural index of 75. When you use a lime source with a different agricultural index, a specific rate of application may be calculated with the following equation:

$$\text{Limestone application rate from soil test} \times \frac{75}{\text{Agricultural index of your limestone}} = \text{Rate of application of your limestone}$$

For example, if a soil test recommends 9 tonnes/ha of limestone and the limestone source has an agricultural index of 90, the application rate should be 7.5 tonnes/ha, because $9 \times 75/90 = 7.5$ tonnes/ha.

The agricultural index does not provide information about magnesium content.

Effect of tillage depth

The lime recommendations presented in Table 3-7, *Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH*, on page 32, should raise the pH of the top 15 cm of soil to the listed target pH. If the soil is plowed to a lesser or greater depth than 15 cm, proportionately more or less lime is required to reach the same target pH. Where shallow tillage depths are used, more frequent applications of lower rates are recommended.

Lowering soil pH

On soils with pH values below 6.5, it is possible, although costly, to lower the pH and make it more acidic. Elemental sulphur is the most inexpensive material to lower pH. Iron sulphate and ammonium sulphate are also effective but much larger quantities are required. Ammonium sulphate should not be applied at rates of nitrogen higher than those recommended for the current crop. If the soil pH is above 6.5, it is not practical to lower it because very large amounts of sulphur or ammonium sulphate will be required. Blueberries require an unusually low pH. Table 3-9, *Sulphur for Soil Acidification*, on page 34, shows the amount of elemental sulphur required to lower the pH of various soils.

TABLE 3-9. Sulphur for Soil Acidification (kg/ha)

Soil type	For each 1.0 pH unit	For each 0.1 pH unit
sand	350	35
sandy loam	750	75
loam	1,100	110

Nitrogen

Nitrogen is an important element for the growth and development of all crop plants. Nitrogen is naturally present in all soils. As soil microbes feed on crop residues and soil organic matter, they release nitrogen into the soil. As soil organic matter levels increase, so do the levels of naturally available nitrogen. Management practices which maintain and increase soil organic matter will also help to enhance crop productivity and soil fertility. Legumes, such as alfalfa and red clover, build soil fertility by capturing atmospheric nitrogen and releasing it into the soil as they decompose.

Nitrogen deficiencies usually first appear on older leaves. These leaves will turn light green or yellow as nitrogen is relocated from older, less productive leaves to the newest growth. Cool growing conditions in early spring often cause plants to develop a temporary nitrogen deficiency. This is usually due to poor growing conditions, and not necessarily a lack of nitrogen in the soil.

Nitrogen and the environment

Soil nitrogen constantly changes. Processes like leaching and denitrification result in the loss of nitrogen from the soil. Denitrification occurs when the soil is waterlogged. Anaerobic microbes convert nitrate and ammonia into nitrous oxide. This gas can contribute to air pollution and is approximately 300 times more potent than carbon dioxide as a greenhouse gas.

The nitrate form of nitrogen, while being readily available to plants, is also very mobile in soil. As a result, nitrates will be carried through the soil with water and have the potential to pollute groundwater and surface water.

When the amount of nitrogen supplied to the crop meets the crop's growth requirements, the risk of losses to the environment is greatly reduced. The potential for nitrogen loss is highest during the late fall and early spring. The application of nitrogen according to the crop's needs reduces residual soil

nitrogen at the end of the season and leaves little available for losses.

It is important to account for fertilizer, manure and other sources of nitrogen when you assess a crop's fertility requirements. Other management practices to reduce the risk of nitrate losses include:

- use of cover crops
- timing nitrogen applications close to crop nitrogen uptake
- reduction of total nitrogen applications

For more information on the nitrogen cycle and its role in the environment, refer to OMAFRA Publication 611, *Soil Fertility Handbook*.

Sources of nitrogen

Synthetic fertilizer

The most common nitrogen fertilizer sources are outlined in Table 3-10. *Fertilizer Materials: Primary Nutrients*, on page 35. Generally, nitrogen sources are equal. Cost, crop management and ease of application will largely determine the selection of one source over another.

If nitrogen is to be applied early in the spring when soils are below 10°C, urea may help prevent leaching losses. Under these conditions, it takes three to six weeks for urea to convert to the plant-available ammonium and nitrate forms. As only nitrate-nitrogen is susceptible to leaching losses, early spring rain will not result in leaching. By the time the nitrate conversion has occurred, the crop is entering its rapid growth phase and minimal downward percolation of water will make leaching less likely.

Products that modify the release of nitrogen

Slow-release fertilizers have been coated in sulphur or a polymer to control the release of the nitrogen over an extended period of time. Nitrification inhibitors are added to these fertilizers to help delay the chemical conversion of urea into the plant available forms. Depending on the weather conditions, the delayed release of these products may not necessarily coincide with peak nitrogen demand, especially when short-season fruits are being grown.

TABLE 3-10. Fertilizer Materials: Primary Nutrients

Nitrogen Materials	Form	% Nitrogen (N)
Ammonium nitrate	Dry	34
Urea	Dry	46
Ammonium sulfate	Dry	20
Calcium ammonium nitrate	Dry	27
Calcium nitrate	Dry	15.5
Urea ammonium nitrate (UAN)	Liquid	28
Anhydrous ammonia	Liquid ¹	82
Phosphate Materials		% Phosphate (P ₂ O ₅)
Single superphosphate	Dry	20
Triple superphosphate	Dry	46
Monoammonium phosphate (11-52-0)	Dry	50 to 52
Diammonium phosphate (18-46-0)	Dry	46
Ammonium polyphosphate (10-34-0)	Liquid	34
Potash Materials		% Potash (K ₂ O)
Muriate of potash	Dry	60 to 62
Sulfate of potash	Dry	50
Sulfate of potash magnesia (11% Mg)	Dry	22
Potassium nitrate (13-0-44)	Dry	44

¹ Liquid under pressure.

Manure nitrogen

In addition to nutrients and micronutrients, manure also supplies valuable organic matter that helps to build and maintain soil structure.

Fifty to 60 per cent of the nitrogen available in manure is available to the crop during the first growing season after application. The remaining organic nitrogen becomes available in small, diminishing quantities in successive years. Up to 10 per cent of the total nitrogen in manure can be available for the following year. Where manure is applied regularly to the same field, there may be a significant amount of residual nitrogen available for a crop.

The quantities of nutrients contained in manure vary between farms. The type of livestock, ration, bedding, added liquids and storage system all affect the final nutrient analysis. Table 3-12, *Average Fertilizer Replacement Values for Different Types of Manure*, on page 36, provides the approximate amount of crop-available nitrogen in manure. A manure analysis,

available from several laboratories in Ontario, provides the most accurate assessment of the nutrients contained in a specific source of manure. Refer to Appendix C, *Accredited Soil-Testing Laboratories in Ontario*, on page 211, for a list of laboratories providing this service.

Use manure responsibly:

- Avoid the spread of manure on frozen or snow-covered ground.
- Avoid application when the potential for runoff is high.
- Tillage prior to the application of liquid manure will help to break up soil cracks and large pores, and prevent the movement of manure into field tiles or shallow groundwater.
- Inject or incorporate the manure to minimize loss of ammonia to the atmosphere and to leave more nitrogen in the soil for the crop.
- When storing manure, follow recommendations in OMAFRA Factsheet, *Temporary Field Storage of Solid Manure or Prescribed Materials*, Order No. 05-009.

Manure and food safety

Fruit can become contaminated in the field if it comes into contact with pathogens that cause human illness. These pathogens may come from manure and manure-based composts. The lifespan of these pathogens in manure is not well known. Proper composting of manure, which results in the compost being heated to a specific temperature for a specific period of time, will reduce the level of most pathogens. For most fruit crops, manure applications within 120 days to harvest are not recommended.

Do you use manure? Don't forget to decrease your fertilizer rate accordingly. For more details refer to Table 3-12, *Average Fertilizer Replacement Values For Different Types Of Manure*, on page 36.

Legumes

Legume crops are able to capture atmospheric nitrogen from the air. As the legume crop residue decomposes, this nitrogen becomes available for subsequent crops. When fruit planting follows alfalfa hay, or a legume cover crop such as red clover, the rate of

fertilizer nitrogen should be decreased according to Table 3-11. *Nitrogen Contribution of Plowed Down Legumes.*

TABLE 3-11. Nitrogen Contribution of Plowed Down Legumes

Type of Sod	For All Crops, Deduct From N Requirement (kg N/ha)
Less than 1/3 legume	0
1/3 to 1/2 legume	55
1/2 or more legume	100
Perennial legumes seeded and plowed the same year	45 ¹
Soybean and field bean residue	0

¹ Applies where the legume stand is thick and over 40 cm high.

Other organic nutrient sources

Biosolids derived from paper mill fibre have been used in orchards and vineyards to maintain soil organic matter. However, before this material can be applied to land, you must have a Certificate of Approval issued by the Ontario Ministry of the Environment (MOE) for the site. Rates depend upon the nitrogen content of the material and can be in the range of 25–30 dry tonnes/ha. However, MOE has final approval of the material and the

Avoid fertilizer burn!

Many nitrogen and potash fertilizer materials contain high amounts of salts. If a germinating seedling or young transplant comes into contact with a concentrated fertilizer band, the tender roots may become seriously damaged. For this reason, it is important to ensure that the correct fertilizer and the appropriate rate are selected for each application.

Urea is an effective, economical source of nitrogen for broadcast applications but it has a relatively high salt index. It is not suitable for use in starter fertilizers or banded applications. If low soil moisture conditions exist at the time of planting, urea burn may occur on coarse sandy-loam soils and growers should consider switching to a different nitrogen source. Anhydrous ammonia also has a relatively high salt index. It is an effective source for side-dress applications that needs to be injected into the soil.

Ensure that starter or transplant fertilizers contain only as much nitrogen as necessary to get the crop started. Fertilizers that contain more than half as much nitrogen as phosphate frequently contain urea and may cause crop damage.

TABLE 3-12. Average Fertilizer Replacement Values for Different Types of Manure

Nutrient values based on average analysis results for over 3,000 samples.

There are large variations between manures, so a manure analysis is your best guide to nutrient availability.¹

Manure	% Average Dry Matter	Available N ² Spring		Available ³ P ₂ O ₅		Available ⁴ K ₂ O	
		kg/1,000 L (lb/1,000 gal)					
Liquid dairy	8.4	1.8	(18)	0.77	(7.7)	2.6	(26)
Liquid hog	3.7	2.7	(27)	1.2	(12.0)	1.9	(19)
Liquid poultry	10.5	5.8	(58)	2.8	(28.0)	3.2	(32)
kg/tonne (lb/ton)							
Solid poultry	55.3	10.5	(21.0)	11.0	(22.0)	13.4	(26.8)
Solid dairy	25.0	1.8	(3.6)	1.5	(3.0)	5.2	(10.5)
Composted dairy	38.3	2.9	(5.8)	2.6	(5.2)	11.8	(23.8)
Solid beef	28.4	1.9	(3.8)	2.1	(4.3)	6.1	(12.2)
Sheep	33.8	2.9	(5.9)	2.6	(5.2)	8.3	(16.7)
Horse	37.4	1.3	(2.6)	1.4	(2.8)	4.6	(9.3)

¹ Data from manure analysis provided from Ontario Labs collected between 1992 and 2007.

² Nitrogen based on spring application, incorporated within 24 hr. Unincorporated manure will have less N due to ammonia losses.

³ Phosphate from manure or biosolids is assumed to be 40% as available in the year of application as that in commercial fertilizer (another 40% of the phosphorus is available the following year).

⁴ Potassium from manure is assumed to be 90% as available in the year of application as that in commercial fertilizer.

applied rate. Any application restrictions are included as conditions on the Certificate of Approval.

Biosolids from sewage treatment plants or paper mill waste can be a useful source of nutrients and organic matter. Guidelines for their use are available from OMAFRA and MOE. A Certificate of Approval for land application is required and is available from MOE. An analysis of nutrients applied should be given by the applicator to the landowner whenever biosolids are applied.

Sewage sludge must not be applied to tree fruits and grapes within three months of harvest. For small fruit (strawberries, raspberries and blueberries) application may not occur within 15 months of harvest.

Always consult with your processor, packer or broker before applying sewage sludge on ground intended for vegetables anywhere in the rotation.

Phosphorus

Like nitrogen, phosphorus is an important component of photosynthesis and the development of enzymes and protein. It also plays an important role in cell division and the creation and transport of sugars and starches.

Soil phosphorus levels across Ontario are variable. Because phosphorus tends to bind to soil particles, it does not leach. Many coarse sandy-loam soils often contain high phosphorus levels. Former tobacco land with a history of regular manure applications have high levels of phosphorus, and fruit crop yield will rarely respond to additional phosphorus fertilizer. Too much phosphorus can induce deficiencies in zinc and iron.

Phosphorus deficiency symptoms usually develop on the older leaves first. The leaves develop a purplish-red colour that may be more noticeable on the underside of the leaves. Severe deficiencies may also cause the leaf tips to die back. Cool, wet soil conditions often trigger phosphorus deficiencies. For early-planted fruit crops, use a starter fertilizer to deliver the required phosphorus directly to the root zone.

Phosphorus in the environment

The main route by which phosphorus leaves the field and enters the environment is through surface runoff. It can be transported in solution with runoff water or through its attachment to eroded soil particles. When this water reaches open surface water, streams can become polluted.

Avoid additional phosphorus applications to soils that test rare response (RR) or no response (NR). If phosphorus is required to promote early season growth, use low rates applied in a band close to the roots or as a starter fertilizer.

Farmers who are required to complete a nutrient management plan must establish a permanent vegetated buffer adjacent to any surface water, with a minimum width of 3 m, prior to any nutrient application. This practice is highly recommended even in situations where it is not a requirement. The grass will help reduce erosion and act as a natural filter for runoff entering the watercourse.

Where phosphorus soil tests are greater than 30 ppm, use the phosphorus index to determine separation distances from surface water sources. The phosphorus index uses a series of five factors, which include field slope, length of slope, soil drainage class and soil texture to determine an appropriate rate and separation distance for phosphorus application from surface water.

For details, see OMAFRA Factsheet, *Determining the Phosphorus Index for a Field*, Order No. 03-109.

Sources of phosphorus

Mineral fertilizers

The most common phosphate fertilizer sources are outlined in Table 3-10. *Fertilizer Materials: Primary Nutrients*, on page 35.

Manure

When properly applied, manure is an excellent, inexpensive phosphorus source. It also supplies the soil with valuable organic matter and micronutrients. Table 3-12. *Average Fertilizer Replacement Values for Different Types of Manure*, on page 36, provides the approximate amount of crop-available phosphorus contained in manure.

Unlike nitrogen, the phosphorus in manure becomes available to crops over a considerable period of time. Regular manure applications may result in a buildup of soil phosphorus which should be monitored with a soil-testing program.

Phosphorus application methods

Phosphorus is not mobile in the soil, therefore broadcasting and incorporating any required phosphorus prior to planting perennial fruit crops is crucial. Some phosphorus is often applied in a band or in transplant solution at planting to ensure good vigour of new plantings. On established perennial crops, it can be broadcast on the surface or banded near the roots. Do not rely on fertigation.

Phosphorus recommendations

Use a soil test from an OMAFRA-accredited lab in conjunction with Table 3-13. *Phosphorus Requirements for Berries, Tree Fruits and Grapes* on this page. For crop specific details see: *Apple Nutrition*, on page 44, *Berry Crop Nutrition*, on page 89, *Grape Nutrition*, on page 126, and *Tender Fruit Nutrition*, on page 143.

TABLE 3-13. Phosphorus Requirements
for Berries, Tree Fruits and Grapes

Soil Phosphorus (ppm)*	New plantings of blueberries, strawberries, raspberries, gooseberries, currants, nursery stock	Established blueberries, strawberries, raspberries, gooseberries, currants, nursery stock	New plantings† of apples, peaches, pears, plums, cherries, grapes
Phosphate (P ₂ O ₅) required – kg/ha			
0–3	140 HR	100 HR	80 HR
4–5	130 HR	90 HR	60 HR
6–7	120 HR	80 HR	50 HR
8–9	110 HR	70 HR	40 MR
10–12	100 HR	70 HR	20 MR
13–15	90 HR	60 HR	0 LR
16–20	70 MR	50 MR	0 LR
21–25	60 MR	40 MR	0 RR
26–30	50 MR	30 MR	0 RR
31–40	40 MR	20 MR	0 RR
41–50	0 LR	0 RR	0 RR
51–60	0 RR	0 RR	0 RR
61–80	0 NR	0 NR	0 NR
80+	0 NR	0 NR	0 NR

HR, MR, LR, RR, and NR denote, respectively, high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

* 0.5 M sodium bicarbonate extract

† For established tree fruits and grapes, plant analysis is used to estimate requirements.

Potassium

Potassium is an important component of plant cells. It also influences the uptake of water by the roots and plays a role in both respiration and photosynthesis. The sugar and starch content of crops like potatoes and tomatoes may be affected by potassium levels. Most crops require equal amounts of potassium and nitrogen.

Potassium deficiency usually appears on the older leaves first. It can cause yellowing or burning of the leaf margins.

Sources of potassium

Mineral fertilizers

The most common potassium sources are outlined in Table 3-10. *Fertilizer Materials: Primary Nutrients*, on page 35.

Manure

Manure is an excellent, inexpensive source of potassium. It also supplies the soil with valuable organic matter and micronutrients. Table 3-12. *Average Fertilizer Replacement Values for Different Types of Manure*, on page 36, provides the approximate amount of crop-available potash contained in manure.

Unlike nitrogen, the potassium found in manure can be held by the soil over a considerable period of time. Regular application of manure over time may result in a build-up of potassium which should be monitored with a soil-testing program.

Potassium application methods

The mobility of potassium fertilizers is limited and falls between that of nitrogen and phosphorus. It is not prone to leaching losses, with the possible exception of very sandy soils low in organic matter. Potash should be broadcast and incorporated prior to planting. After establishment where a drip irrigation system is used, up to half of the potassium requirement can be applied by fertigation. At least half of the potassium should be applied in the spring as a broadcast or band in the drip-line of the crop or in the herbicide strip. Potassium can be blended with nitrogen and applied in one pass.

Foliar applications can be made in grapes and should be considered in dry years when soil uptake is

TABLE 3-14. Potassium Requirements for Berries, Tree Fruits and Grapes

Soil Potassium (ppm K)*	New or Established blueberries, strawberries, raspberries, gooseberries, currants, nursery stock	New plantings† of apples, peaches, pears, plums, cherries	New plantings‡ of grapes
Potash (K2O) required – kg/ha			
0–15	130 HR	180 HR	270 HR
16–30	120 HR	170 HR	270 HR
31–45	110 HR	160 HR	270 HR
46–60	100 HR	140 HR	270 HR
61–80	90 HR	110 HR	270 HR
81–100	80 HR	70 MR	270 HR
101–120	70 MR	40 MR	270 HR
121–150	60 MR	20 MR	270 MR
151–180	40 MR	0 LR	270 MR
181–210	0 LR	0 LR	270 MR
211–250	0 RR	0 RR	270 LR
250+	0 NR	0 NR	270 LR

HR, MR, LR, RR, and NR denote, respectively, high, medium, low, rare and no probabilities of profitable crop response to applied nutrient

* 1 M ammonium acetate extract

† For established tree fruits and grapes, plant analysis is used to estimate requirements.

‡ Apply only every second year.

reduced. Foliar application at veraison may improve yield of grapes.

Potassium recommendations

Use a soil test from an OMAFRA-accredited lab in conjunction with Table 3-14. *Potassium Requirements for Berries, Tree Fruits and Grapes*, on this page. For crop specific details see: *Apple Nutrition*, on page 44, *Berry Crop Nutrition*, on page 89, *Grape Nutrition*, on page 126, and *Tender Fruit Nutrition*, on page 143.

Excessive potassium applications reduce a crop's ability to take up magnesium from the soil. Where potassium levels are high, magnesium deficiencies are more likely to occur, particularly if magnesium levels are already low.

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance in tree fruits. In apples and tender fruits, do not ex-

ceed 3 kg of potash per tree even in cases of severe deficiency.

In blueberries, currants and gooseberries, do not use muriate of potash (0-0-60) due to their sensitivity to chloride.

In apples and tender fruits, do not exceed 3 kg of potash per tree even in cases of severe deficiency.

Calcium

Calcium is a vital component of cell walls and is involved in the movement of sugars and starches within the plant. Calcium moves through the plant almost exclusively with the transpiration stream.

Calcium deficiencies may cause the growing point to die. It may also cause the blossoms and buds to drop prematurely.

Calcium deficiencies rarely occur in fruit crops grown on soils with a pH of 6.0–7.5. On coarse sandy loam soil, with acidic or low pH, additional soil or foliar calcium may be required. Refer to Table 3-16. *Application Rates for Magnesium, Calcium and Micronutrients*, on page 40. Calcium-related disorders may occur in some crops, for example tip burn in strawberries, gummosis in plums, and bitter pit in some apple varieties.

Several management practices will reduce the occurrence of calcium-related disorders. Avoiding over-application of nitrogen will help prevent excessive vegetative growth which can dilute the calcium in the plant. Good soil management practices ensure good root growth, which will promote both water and nutrient uptake. Timely irrigation will help keep calcium moving into the plant.

Foliar applications of calcium can be made to reduce the incidence of bitter pit in apples, gummosis in European plums, stem and bunch breakdown in certain varieties of grapes and various problems in pears. Only apply foliar calcium if a problem is anticipated because of the potential for leaf burn and premature ripening. Crop-specific recommendations can be found for apples on page 48, grapes on page 128 and plums and pears on page 147. Do not concentrate sprays or leaf burn could occur. To avoid adverse effects on fruit quality and storability, do not apply calcium formulations containing nitrogen beyond the end of July unless correcting a nitrogen deficiency. Consult OMAFRA Factsheet, *Bitter Pit Control in Apples*, Order No. 00-009.

Magnesium

Magnesium is an essential part of chlorophyll and aids in the formation of sugars, oils and fats.

In apples, magnesium deficiency can cause premature fruit drop, especially with McIntosh.

A foliar spray will correct magnesium deficiency in the current year only, and should be combined with soil application for a longer term solution.

Magnesium is mobile within the plant and therefore deficiency usually appears first on the older leaves as it translocates to the growing tissue. The leaf tissue between the veins turns yellow, while the veins remain green. Severe deficiencies will cause the leaf margins to curl.

In conjunction with an OMAFRA-accredited magnesium soil test, consult Table 3-15. *Magnesium Soil Test Ratings and Interpretations for all Fruit Crops*, on this page.

Excessive potassium applications can induce a magnesium deficiency, therefore avoid using high rates of potash on soils with a low magnesium rating.

Micronutrients

Micronutrients include boron, copper, iron, manganese, molybdenum and zinc. Plants use these elements in much smaller amounts than the major nutrients like nitrogen, phosphorous, potassium, calcium and magnesium. Because such small quantities are required, routine application is generally an unnecessary expense. However, micronutrients

TABLE 3-15. Magnesium Soil Test Ratings and Interpretation for all Fruit Crops

Soil Magnesium* (ppm Mg)	Rating	Recommendation
Below 20	HR	Magnesium should be applied for all crops. If pH is below 6.5 apply dolomitic lime. At higher pH values apply 30 kg soluble magnesium (Mg)/ha. Potash applications in excess of those recommended by soil test will increase the probability of Mg deficiency.
20–39	MR	Magnesium is not required unless potassium soil test is above 250. If soil test K is above 250 and pH is below 6.5 apply dolomitic lime. At higher pH values with K above 250, apply 30 kg soluble magnesium (Mg)/ha.
40–100	LR	If lime is required use dolomitic.
100+	NR	If lime is required either dolomitic or calcitic may be used.
* 1 M ammonium acetate extract HR = high response; MR = medium response; LR = low response; NR = no response to applied nutrient.		

TABLE 3-16. Application Rates for Magnesium, Calcium and Micronutrients

A number of micronutrients are available as chelates, with various formulations and nutrient contents. Check the product labels for crop specific recommendations. The effective use rate for chelated products is the same as for other formulations.

Nutrient	Soil Applied		Source	% Composition	Foliar Applied	
	Nutrient kg/ha	Product kg/ha			Nutrient kg/1,000 L	Product kg/1,000 L
Calcium (Ca)	–	–	calcium chloride	36% Ca	1.9	5.0
	–	–	calcium nitrate	19% Ca	1.9	10.0
Magnesium (Mg)	120–260	2 tonnes/ha	dolomitic limestone	6–13% Mg	–	–
	30	285	epsom salts	10.5% Mg	1.9	18
	30	270	sulphate of potash magnesia	11% Mg	–	–
Boron (B)	1.0–3.0	–	sodium borate	12–21% B	0.1–0.3	–
Copper (Cu)	7.0–14.5	28–60	copper sulfate	13–25% Cu	0.5–1.5	2–6
	–	–	copper chelates	5–13% Cu	0.5–1.5	–
Manganese (Mn)	–	–	manganese sulfate	28% Mn	0.5–1.0	1.8–3.6
	–	–	manganese chelates	5–12% Mn	0.5–1.0	–
Molybdenum (Mo)	–	–	sodium molybdate	39% Mo	0.1–0.25	0.25–0.6
Zinc (Zn)	4–14	11–33	zinc sulfate	36% Zn	0.6	1.6
	4–14	–	zinc oxysulfate	18–36% Zn	–	–
	–	–	zinc chelate	9–14% Zn	0.6	–

are crucial to plant growth and deficiencies must be corrected.

Micronutrients are usually found in much lower levels in the soil than macronutrients. Soil pH, organic matter, clay and mineral content can strongly influence micronutrient availability. This makes soil tests for estimating micronutrient availability less reliable than those for the primary nutrients.

Which to choose: soil or foliar fertilizers?

Both soil and foliar fertilizers have a role to play in fruit crop production. The major nutrients (nitrogen, phosphorus, potassium, calcium and magnesium) are required in relatively high amounts for crop growth. As a result, soil application is almost always the most efficient and economical method of getting these nutrients into the plant. Foliar uptake occurs through the leaf's cuticle and the stomata. The amount of nutrients that can enter the plant through these means is quite limited. Higher application rates may lead to crop injury.

Since micronutrients are required in much lower quantities, they can often be efficiently delivered through foliar applications, especially when soil conditions limit micronutrient availability. If a micronutrient deficiency is found, foliar application is the quickest way of addressing it. This can be followed with a soil application to prevent a recurrence, depending on the micronutrient and the soil pH.

Do not apply micronutrients to fruit crops unless a deficiency is identified. Apply only the deficient nutrient in sufficient quantities to correct the problem. The range between deficiency and toxicity with micronutrients can be narrow.

Use caution when you apply mixtures of several micronutrients, as crop injury may occur. Always follow the product label. Do not combine micronutrients with insecticide, fungicide or herbicide sprays unless there is information from the manufacturer of each product that indicates the mixtures are compatible. Many chelated micronutrients will consolidate in the spray tank if mixed with pesticides. Use caution when applying micronutrients through fertigation systems. Certain micronutrient blends may plug the emitters.

Foliar applied nutrient uptake can be improved through the timing of the application and the use of surfactants. Younger leaves generally have a less well-developed cuticle and are able to take up more

of the nutrient. Early morning applications may favour foliar uptake, and drought stress that results in a thicker cuticle may hinder uptake. Avoid the application of foliar nutrients during the heat of the day when leaves will dry quickly. Ensure good leaf coverage, particularly on the underside.

Boron

Boron plays an important role in the structure of cell walls, fruit set and seed development. It is also a component of protein and carbohydrate metabolism.

Boron deficiency is most likely to be found on alkaline soils or sandy knolls. Symptoms vary widely between crops. Apples may exhibit internal breakdown and premature drop of highly coloured fruit. Boron toxicity may occur when sensitive crops are planted in a rotation where boron has been applied or over-applied.

There is no OMAFRA-accredited boron soil test. Some soil test reports provide a soil boron value, however, soil levels are often less than 1 ppm, which makes it very difficult to get an accurate measurement. To correct deficiency, fertilizer manufacturers may mix boron sources with ordinary fertilizers. Boron can also be foliar applied for faster results. If boron is required, refer to Table 3-16. *Application Rates for Magnesium, Calcium and Micronutrients*, on page 40.

Some crops are very sensitive to boron, even at low levels. A soil pH between 5.0 and 7.0 provides the best conditions for boron uptake. Boron deficiencies are more likely to occur on soils with low organic matter and on exposed or eroded subsoils. Boron availability decreases during periods of drought.

Copper

Copper plays a role in chlorophyll production. It may also have a role in the suppression of some diseases.

Copper deficiency is rare on mineral soils, except perhaps very sandy soils.

Since soil tests are unreliable, there is no OMAFRA-accredited copper soil test. Plant tissue analysis is a more useful tool. If copper is required, refer to Table 3-16. *Application Rates for Magnesium, Calcium and Micronutrients*, on page 40. Use extreme care when you apply copper sulphate to leaves.

Iron

Iron is needed for chlorophyll formation, plant respiration and the formation of some proteins.

Iron deficiency, also called lime-induced chlorosis, is rare in Ontario. Symptoms appear on the young leaves first. Leaves turn yellow between the veins, but the veins will remain green except in extreme cases. Often symptoms are seen in only one area of the plant. Factors associated with iron deficiency include soils with high lime content (and therefore high pH), and gross imbalances with other micronutrients like molybdenum, copper or manganese.

An iron soil test does not correlate well with plant uptake or fertilizer response in Ontario. Consequently there is no OMAFRA-accredited iron soil test. Plant analysis is a much more reliable indicator of iron availability. Iron deficiency is easily corrected with the foliar application of iron chelates. Soil application is not generally effective. Refer to Table 3-16. *Application Rates for Magnesium, Calcium and Micronutrients*, on page 40 and consult the manufacturer's label for information on rates and timing.

Manganese

Manganese is involved in photosynthesis and chlorophyll production. It helps activate enzymes involved in the distribution of growth regulators within the plant.

Manganese deficiency causes yellowing between veins of young leaves. Leaves gradually turn pale-green with darker green next to the veins. Manganese toxicity can occur on soils with a low pH. It causes brown spots or yellow mottled areas near leaf tips and along the leaf margins and usually develops on older leaves. Brown spots may also develop on veins, petioles and stems.

The OMAFRA-accredited manganese soil test uses a manganese availability index. This index evaluates manganese availability based on soil manganese level and soil pH.

Foliar applied manganese is generally preferred because the higher soil pH that may lead to deficiency tends to make added manganese unavailable. Soil-applied manganese may be useful in acidic, sandy soils. On alkaline soils banded applications are often more effective than broadcast. If a deficiency is confirmed, apply foliar sprays when the plants are about one-third grown or sooner. Two or more sprays may be necessary at ten day intervals.

If manganese is required, refer to Table 3-16.

Application Rates for Magnesium, Calcium and Micronutrients, on page 40.

Manganese availability is greatest at a soil pH of 5.0 to 6.5. It is important not to add more lime than is needed to correct soil acidity. High organic matter levels decrease manganese availability. Foliar applications may be required for crops grown on muck soils.

Zinc

Zinc is important in early plant growth and in seed formation. It also plays a role in chlorophyll and carbohydrate production.

Zinc is relatively immobile within the plant. Deficiency symptoms appear first on younger leaves. Young leaves become mottled and show interveinal chlorosis, striping or banding. In advanced stages in tree fruits, small, narrow terminal leaves are arranged in whorls or "rosettes." This results in the typical "rosette" and "little leaf" description for zinc deficiency. Use leaf and soil analysis to test for zinc deficiency.

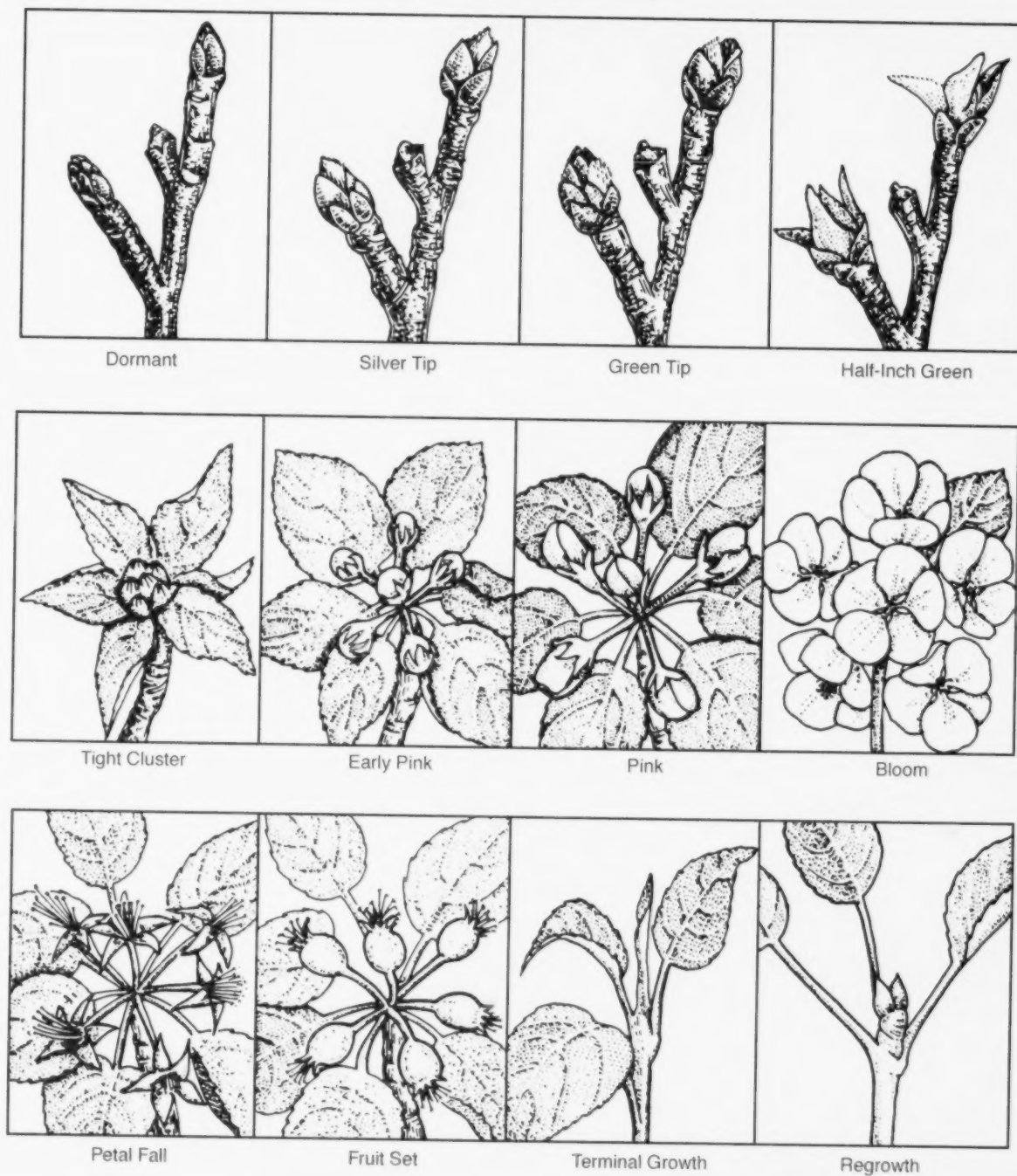
The OMAFRA-accredited zinc soil test is reported as a zinc index value, which estimates availability based on soil zinc level and soil pH. Zinc deficiency can be prevented by the application of zinc fertilizer to the soil at a rate of 4 kg of zinc/ha. Broadcasting up to 14 kg of zinc/ha will correct a deficiency for three years. No more than 4 kg zinc/ha should be banded. Early in the growing season, foliar sprays can be used to correct a deficiency after the symptoms have appeared. If zinc is required, refer to Table 3-16. *Application Rates for Magnesium, Calcium and Micronutrients*, on page 40.

Zinc deficiencies are most often seen on sandy soils with high pH levels. Heavily eroded knolls may also have deficiency problems. Large applications of phosphorus may aggravate zinc deficiencies. Livestock manure is often an excellent source of zinc.

Where a zinc deficiency exists, check manufacturer's recommended rates and timing of applications of zinc products. If zinc is required, refer to Table 3-16. *Application Rates for Magnesium, Calcium and Micronutrients*, on page 40. Foliar applications early in the growing season can be used to correct a deficiency after the symptoms have appeared.

4. Apples

FIGURE 4-1. Apple Growth Stages



Apple Nutrition

It is important to test the soil a year in advance of planting apple trees, or two years where pH adjustment may be necessary. Before planting is the only opportunity to thoroughly incorporate organic matter, phosphorus, potassium, and lime. These materials are required to optimize orchard productivity but do not move readily through the soil profile.

Manure for Orchards

Manure contains beneficial organic matter and a host of macro and micronutrients. The disadvantage of adding manure to orchards is that the organic nitrogen is mineralized over time. This slow release means the orchard receives a continuous supply of available nitrogen throughout the season. Excessive nitrogen, particularly in the second half of the growing season, can result in poor fruit colour, reduced storability, excessive growth and delayed cold-hardening of the woody tissue, which makes trees more susceptible to winter injury. Observe the following guidelines to receive the benefits of manure while minimizing potential problems:

- Apply no more than 7 tonnes/ha of poultry manure (20 m³ liquid), 40 tonnes/ha of cattle manure (100 m³ liquid), and 35 tonnes/ha hog manure (65 m³ liquid). Since the nutrient content of manure varies greatly, conduct nutrient analysis before application. See *Manure nitrogen*, on page 35.
- Broadcast manure at moderate rates and work into the soil in late fall or early spring before planting. Do not put manure around newly planted trees because of potential winter injury problems.
- Reduce the rate of nitrogen, phosphorus and potassium fertilizers applied. Table 3-12. *Average Fertilizer Replacement Values for Different Types*

of Manure, on page 36, shows the average composition of some manures and suggested reduction of fertilizer when manure is used.

- For more information about food safety and the environmental impacts of manure application see *Manure nitrogen*, on page 35, and *Use manure responsibly*, on page 35.

pH Requirements

The pH of a soil is a measure of its acidity and affects nutrient uptake and crop performance. Prior to planting, soil pH should be adjusted prior to planting to a pH of 6.5 on sandy soils and 6.0 on clay soils.

In established orchards, sample soil in the tree row every three years to ensure the pH is satisfactory. If the pH on clay loam soils drops below 5.1 and on sandy soils below 5.6, apply lime to the sod cover in the fall or before spring cultivation. The results do not show immediately because lime moves and reacts slowly in the soil.

For details regarding rates and suggested types of lime to use, refer to *Soil pH and Liming*, on page 31.

Leaf Analysis

In established plantings, leaf analysis is the best method to determine nutrient needs. The nutrient levels in these plant tissues most accurately reflect the tree's uptake of nutrients. Soil analysis is used in conjunction with leaf analysis to determine the nutrient status of the soil and to monitor soil acidity. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests, see *Plant tissue analysis*, on page 29.

Many orchard conditions affect nutrient uptake. Consequently, nutrient levels vary slightly each year depending on the season. To obtain optimum growth and fruit quality, all nutrients must be

TABLE 4-1. Foliar Nutrient Sufficiency Range of Apple (Mid-Shoot Leaves Taken in Last Two Weeks of July from Mature Trees)

Variety	N*	P	K	Ca	Mg	Fe	B	Zn	Mn
	%					ppm			
Delicious, Crispin	2.2–2.7	0.15–0.40	1.4–2.2	0.8–1.5	0.25–0.40	25–200	20–60	15–100	20–200
Empire, Spy	2.1–2.6	0.15–0.40	1.3–2.1	0.7–1.5	0.25–0.40	25–200	20–60	15–100	20–200
McIntosh, others	2.0–2.5	0.15–0.40	1.2–2.0	0.8–1.5	0.25–0.40	25–200	20–60	15–100	20–200

* Leaf nitrogen in non-bearing trees should be 0.2% higher.

Leaf nitrogen on M.9 or M.26 rootstocks should be 0.2% higher.

present at concentrations in the sufficiency range in the leaves.

For leaf analysis to be effective, sample the same trees each year and make adjustments to the fertilizer program on the basis of this leaf analysis. Consult Table 4-1. *Foliar Nutrient Sufficiency Range of Apple*, on page 44 to find the optimum nutrient level ranges for apples.

Fertilizer requirements are adjusted to soil management practices, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered to determine the fertilizer required. Further information is available in OMAFRA Factsheet *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

Fertilizer for Apples

Fertilizer for non-bearing apples

The best time to effectively incorporate nutrients such as potassium, phosphorous, boron and lime into the soil is prior to planting the orchard. Adequate nutrient levels in the topsoil are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. Table 4-2. *Phosphorus and Potassium Soil Requirements Before Planting Apples*, on this page, provides information on fertilizer rates prior to planting.

In the early years, before new trees bear their first crop, an annual early spring application of nitrogen and potash is usually required. For suggested rates, refer to Table 4-3. *Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Densities and Tree Ages, Growing in Sod*, on page 46 and Table 4-4. *Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod*, on page 47.

On young trees, broadcast the fertilizer under the spread of the branches at least 15 cm from the trunk, since injury can result if placed too close. If the soil was prepared properly through deep cultivation and the addition of organic matter such as manure, there should be an adequate supply of other nutrients to sustain the orchard in its juvenile years.

On coarse-textured, infertile soils, it may help to use a starter solution at planting time, such as 10-52-10 or 20-20-20.

TABLE 4-2. Phosphorus and Potassium Soil Requirements Before Planting Apples

Soil phosphorus		Soil potassium	
New plantings of apples*		New plantings of apples*	
Soil test (ppm P)	Phosphates (P ₂ O ₅) req'd kg/ha	Soil test (ppm K)	Potash (K ₂ O) req'd kg/ha
0–3	80 HR	0–15	180 HR
4–5	60 HR	16–30	170 HR
6–7	50 HR	31–45	160 HR
8–9	40 MR	46–60	140 HR
10–12	20 MR	61–80	110 HR
13–15	0 LR	81–100	70 MR
16–20	0 LR	101–120	40 MR
21–25	0 RR	121–150	20 MR
26–30	0 RR	151–180	0 LR
31–40	0 RR	181–210	0 LR
41–50	0 RR	211–250	0 RR
51–60	0 RR	250 +	0 NR
61–80	0 NR		
80 +	0 NR		

* For established apple trees, use leaf analysis to estimate requirements of N, P and K.
HR, MR, LR, RR, and NR denote, respectively, high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

High nitrogen levels can result in excessive growth and incomplete tree hardening. Cover crops are strongly recommended to check late season growth in cultivated orchards, especially in new plantings. Cover crops such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil and will check the tree growth.

Fertilizer for bearing apples

Most bearing orchards require annual applications of both nitrogen (N) and potassium (K) fertilizer. These two elements significantly affect growth and productivity.

Nitrogen (N)

Nitrogen is necessary for many tree functions, including growth, fruit bud formation, fruit set and fruit size. Because of the complexity of nitrogen interactions with quality and production, the best guide for nitrogen rates is leaf analysis.

Cultivars differ in nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In some situations,

TABLE 4-3. Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Densities and Tree Ages, Growing in Sod*

Tree Age (years)	TREE DENSITY											
	ha	600	800	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600
	acre	240	320	400	480	560	640	720	800	880	960	1,040
1		30	30	30	30	30	30	30	30	30	30	30
2		60	60	60	60	60	60	60	60	60	60	60
3		90	90	90								
4		120	120	120								
5		150	150	150								
6		180	170	168								
7		206	190	186								
8		232	210	204								
9		258	230									
10		284	250									
11		310										
12		336										
13 or older												

Use leaf analysis to determine nitrogen needs.

Reduce nitrogen rate by half if orchard is cultivated without sod between tree rows.

Do not exceed 200 kg of actual nitrogen per ha per season regardless of number of trees per ha.

* These are approximate values. The exact amount of nitrogen to apply is a function of soil nitrogen level, cultivar, rootstock, soil moisture, etc.

The best way to determine nitrogen requirements is with regular leaf analysis.

if fruit tends to be small, more nitrogen may be needed. Rootstocks, spacing and pruning also influence application rates.

Tree growth, foliage colour, fruit quality such as colour and storability, nutrient balance in leaves and soil are also important considerations.

- Several forms of nitrogen are available, but ammonium nitrate (34-0-0) or calcium ammonium nitrate (27-0-0) are the most economical. If you use blended fertilizers, request ammonium nitrate as the nitrogen source.
- Do not apply urea (46-0-0) to sod orchards since some nitrogen is lost by volatilization.

Nitrogen rates

Given the variety of orchard systems, rootstocks, cultivars and soil types, the exact amount of nitrogen to apply varies. Use leaf analysis to evaluate the nitrogen needs of specific plantings. Table 4-3. *Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Densities and Tree Ages, Growing in Sod*, on this page is an estimate of possible nitrogen requirements. When the tree canopy

covers the available space, nitrogen fertilizer requirements level out and do not increase indefinitely with tree age. Orchards grown under clean cultivation require about half the nitrogen required by orchards grown in sod.

- For all apple cultivars, do not exceed the maximum rates of 200 kg actual nitrogen per ha per year, even in the case of a severe deficiency.
- If pruning is to be severe, cut back on nitrogen rates or eliminate for a year.
- Do not apply excessive amounts of nitrogen. Late or excessive applications result in poor fruit colour and quality. Also, available nitrogen late in the season may affect hardening off and increase the possibility of winter injury.
- In cultivated orchards, use cover crops to help lower the nitrogen level in the latter part of the season. Cover crops such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil and limit tree growth.
- In orchards with herbicide-treated strips under trees, allow some weed growth late in the season.

TABLE 4-4. Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod*

		TREE DENSITY											
Tree Age (years)	ha	< 500	600	800	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600
	acre	< 200	240	320	400	480	560	640	720	800	880	960	1,040
	1	80	80	80	80	80	80	80	80	80	80	80	80
	2	80	80	80	80	80	80	80	80	80	80	80	80
	3	80	80	80	80								
	4	80	80	80	80								
	5	80	80	80	80								
	6	80	80	80	80								
	7	80	70	63	52								
	8	80	70	63	52								
	9	80	70	63	52								
	10	80	70	63	52								

Use leaf analysis to determine potash needs.

Do not exceed 800 kg of 0-0-60 per ha per season regardless of number of trees per ha.

* These are approximate values. The exact amount of muriate of potash to apply is a function of soil potassium level, cultivar, rootstock, soil moisture, etc. The best way to determine potash requirements is by leaf analysis.

Weeds will take up extra nitrogen, which helps harden off trees and improve fruit quality.

Nitrogen placement and timing

- Apply nitrogen fertilizer in early April.
- In cultivated orchards, broadcast nitrogen under the tree canopy.
- In sod orchards, place the nitrogen in a band under the drip line or in the herbicide strip.

Foliar application of nitrogen

Foliar applications of urea (46% nitrogen) have been used successfully on apples when weather or crop conditions resulted in the need for additional nitrogen at a critical time. Late applications may adversely affect fruit quality.

- On apples, use no more than 2.7 kg N/1,000 L water (6 kg urea) and apply at least 2,000 L/ha starting 7–10 days after petal fall.
- Space the sprays about 10 days apart. Do not apply more than three times.
- Do not apply later than the end of July or fruit quality and winter survival of the tree could be adversely affected.
- Urea sprays are not a substitute for soil applications if nitrogen is required.

Phosphorus (P)

Phosphorus is not required in large amounts by apple trees. With a few exceptions, the level of phosphorus in Ontario soils is generally adequate without additional applications. Phosphorus may be required for sod or cover crop maintenance. A soil test is the best way to determine if this nutrient needs to be added to the sod cover. If indicated, apply phosphorus before planting so it can be thoroughly incorporated in the soil. Phosphorus soil test values between 12–20 ppm are considered adequate for tree establishment and fruit production.

Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance. Because an excess of potassium can lead to a deficiency of magnesium (Mg), avoid unnecessary potassium applications. Potassium soil test values between 120–150 ppm are considered adequate when planting fruit trees. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available, use the approximate rates in Table 4-4. *Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod*, on this page.

Apply no more than 3 kg of K₂O (5 kg of muriate of potash) per mature standard apple tree in a year,

regardless of how severe the potassium deficiency. When you fertilize trees on dwarfing rootstocks, consult Table 4-4, on page 47 for approximate rates of muriate of potash to apply. When the tree canopy has covered the space available, potassium fertilizer requirements level out and do not increase indefinitely with tree age. Leaf analysis is the most reliable guide to determine potassium requirements.

Placement and timing

- The best time to apply potassium, either separately or combined with nitrogen, is the spring. While some growers prefer the fall because of time constraints in the spring, leaching over winter may cause potassium loss. For this reason apply in spring if possible.
- In sod orchards, apply potash in a band around the dripline or in the herbicide strip.

Calcium (Ca)

A lack of calcium is associated with fruit problems such as bitter pit of apple.

Foliar application of calcium (Ca) to apples reduces the incidence of bitter pit and cork spot. Where these disorders have been a problem, apply four foliar sprays two weeks apart, beginning in mid-July. See Table 4-5. *Calcium Foliar Sprays*, on page 49. Where more calcium is required, make additional applications by either beginning earlier around mid-June or by continuing until harvest.

Calcium advances fruit maturity, so the timing of harvest may need to be adjusted as a result of calcium foliar sprays.

Some formulations of calcium chloride (CaCl_2), if applied too close to harvest, have resulted in poor fruit finish. Calcium sprays must contact the fruit for uptake to be effective. Therefore water volumes capable of wetting the entire tree are required. The more calcium applied the better the control; however, high concentrations of calcium can cause foliar burn.

- Do not concentrate CaCl_2 (77% flakes) beyond 5 kg/1,000 L of water in mid-July and no more than 7 kg/1,000 L for applications at or beyond mid-August.
- Do not apply calcium formulations that contain nitrogen after the end of July or fruit quality and storability may suffer.

- For all formulations, consult the label directions for concentrations and compatibility with pesticides. The product used is not as important as the total amount of actual or elemental calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results, up to 12 kg/ha of actual calcium is often required in a total of four or more sprays.

Calcium sprays may cause foliage and/or fruit injury if applied when low temperature and wet weather delay drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

Recent studies with calcium sprays on McIntosh failed to show an advantage in fruit firmness and keeping quality when fruit was stored in regular controlled atmosphere storage for five and a half months. Limit applications of calcium to fruit that has a known deficiency and/or is prone to bitter pit or cork spot. For more information on calcium disorders, consult OMAFRA Factsheet, *Bitter Pit Control in Apples*, Order No. 00-009.

Magnesium (Mg)

Magnesium soil test values between 100–250 ppm are considered adequate when you plant fruit trees. Magnesium deficiency has become more evident in orchards, particularly where high rates of potash have been used. Magnesium deficiency can lead to premature drop of fruit at harvest, especially with McIntosh. As magnesium is a part of the chlorophyll molecule, magnesium deficient trees have older leaves that are pale in colour. Leaf analysis is the best way to evaluate magnesium requirements.

Foliar sprays of magnesium effectively correct this deficiency for the current year only. See Table 4-6. *Magnesium Foliar Sprays*, on page 49.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate. Apply magnesium sulfate separately or try the mixture on a few trees first. Check manufacturer's label in regard to the mix of magnesium chelates¹ with pesticides.

For long-term corrections, soil applications of magnesium are required; however, crop response is not usually immediate. On some soil types a single, early spring application of soil-applied magnesium may not work. A second or third application the next

¹ Use chelates recommended for foliar sprays.

TABLE 4-5. Calcium Foliar Sprays

Timing	Product	Rate	Notes
Four sprays spaced two weeks apart beginning in mid-July. Additional sprays can be applied up to harvest.	Calcium chloride* (77% flakes)	5 kg/1,000 L water	Not recommended on McIntosh or Idared. Wet tree to point of runoff. Pesticides may not be compatible — check label.
	Calcium nitrate	9 kg/1,000 L water	Use only if leaf nitrogen is low. Do not apply later than the end of July. For pesticide compatibility consult labels.
	Other formulations including chelates	Consult label	

* When using calcium chloride, mix required calcium in a pail of water first to be sure all product is dissolved before adding slurry to spray tank.

TABLE 4-6. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
Three sprays spaced two weeks apart beginning at calyx	Magnesium sulfate (epsom salts)	20 kg/1,000 L water	Wet tree to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

spring may be needed before the magnesium level in the tree improves. To be sure fruit drop is not a problem in this waiting period, apply foliar magnesium sprays for the first two years, in addition to soil applications.

- Use dolomitic limestone to supply magnesium and raise the soil pH on acidic soils.
- Where lime is not required, apply 5–7 kg per mature standard tree and 3–4 kg per mature dwarf tree of sulphate of potash magnesia. This is a granular fertilizer that contains approximately 21% potash and 11% magnesium. Apply this material in early spring in a band under the tree dripline. It contains potassium (K) and the rate of application depends on potash needs. Other sources of magnesium also work well as a soil application.
- If magnesium is blended with the fertilizer, apply at least 80 kg of available magnesium per ha when the fertilizer is spread.

Warning: Do not concentrate nutrient spray. Do not spray at temperatures above 25°C.

Micronutrients for Apples

Deficiencies of micronutrients or trace elements are not widespread in Ontario apple plantings. Boron deficiency is perhaps the most common. Deficiencies of zinc, manganese and iron appear occasionally, particularly in alkaline or high pH soils.

The desirable range for micronutrients is very small. More damage is possible with excess amounts than with deficiencies.

- Do not apply micronutrients to apples except when deficiency is confirmed by leaf analysis or visible symptoms.
- Apply only the nutrient that is deficient in sufficient quantities to correct the problem.

For more information on micronutrients in apples, see *Micronutrients*, on page 40.

Apple Calendar

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point. Check Table 4-7, *Products Used on Apples*, on page 66.

Products are listed according to insecticide and fungicide family groups. Use products from different family groups to prevent pest resistance.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Dormant			
San Jose scale European fruit scale Lecanium scale	<ul style="list-style-type: none">Superior 70 Oil	20 L of oil/1,000 L of water	Apply full rate of oil in 2,000–3,000 L of water per ha. 3,000 L gives best results. On large standard trees, use 90 L of oil in 4,500 L of water per ha. Do not use oil within 48 hours of freezing temperatures. Do not use oil within 14 days of Captan or Maestro. Maximum one application per season.
OIL MAY CAUSE BARK INJURY ON RED DELICIOUS, EMPIRE AND CRISPIN (MUTSU).			
Green tip up to half-inch green			
Scab protectants	<ul style="list-style-type: none">Manzate Pro-stick or Dithane DG or Penncozeb 75 DFPolyram DFDikarSupra Captan 80 WDG or Maestro 80 DFVangard 75 WGScala SC	<div>6.00 kg</div> <div>6.00 kg</div> <div>see label</div> <div>6.00 kg</div> <div>6.75 kg</div> <div>3.75 kg</div> <div>3.75 kg</div> <div>370 g</div> <div>1.00 L</div>	<p>Apply fungicide before spore release and keep growing leaves covered. Alternate materials in a spray program.</p> <p>Dikar: When used in a full season program, Dikar will suppress mites. Higher water volumes help mite suppression. Consult label.</p> <p>Vangard or Scala: Use as protectant fungicides. Vangard and Scala do not control other foliar or fruit diseases. Vangard and Scala are from the same fungicide family and should not be used in rotation. Maximum two applications per season, prebloom only.</p>
Powdery mildew	If powdery mildew was a problem in previous years, then an application of a fungicide is necessary at this time. Use one of the fungicides listed at <i>Tight cluster to pink</i> , on page 52.		
Half-inch green to tight cluster			
European red mite	<ul style="list-style-type: none">Superior 70 Oil	20 L of oil/1,000 L of water	<p>Apply Superior 70 Oil for the control of European red mite before overwintering eggs hatch. Usually the best timing is between Half-inch green to tight cluster when temperatures are getting warmer.</p> <p>Do not apply full rate of oil more than once per season. Apply oil in 2,000–3,000 L of water per ha. 3,000 L gives best results. On large standard trees, use 90 L of oil in 4,500 L of water per ha. Do not use oil within 14 days of Captan or Maestro.</p>
OIL MAY CAUSE BARK INJURY ON RED DELICIOUS, EMPIRE AND CRISPIN (MUTSU).			
Rosy apple aphid	<ul style="list-style-type: none">Assail 70 WPActara 25 WG	<div>120 g</div> <div>160 g</div>	<p>Assail and Actara: Both are in the same chemical family and should not be used in rotation. Maximum 4 neonicotinoid applications per season. Repeated use of some neonicotinoids may result in mite outbreaks.</p> <p>Actara: Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom, and wait at least 5 days after treatment before placing beehives in or near treated fields.</p>

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Scab	• Manzate Pro-stick or Dithane DG or Penncozeb 75 DF	6.00 kg 6.00 kg see label	Sovran, Flint, Nova/Nustar: Should not be used earlier than Tight cluster . After last application tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications. Check labels for details. Do not use Nova, Nustar, Flint or Sovran once apple scab is present. Use of these products as eradicants may result in the development of fungicide resistance. See Table 2-8. <i>Fungicide/Bactericide Groupings Based on Sites of Action</i> , on page 16. The following products are compatible with oil: <ul style="list-style-type: none">• Polyram DF• Dithane DG• Manzate DF When mixing fungicides with oil, add fungicide to tank when $\frac{1}{4}$ to $\frac{1}{2}$ full of water and mix thoroughly. Add Superior 70 Oil last when tank is at least $\frac{1}{2}$ full of water. Do not use oil within 14 days of Captan or Maestro.
	• Polyram DF	6.00 kg	
	• Supra Captan 80 WDG or Maestro 80 DF	3.75 kg 3.75 kg	
	• Dikar	6.75 kg	
	• Sovran	240 g	
	• Flint 50 WG	140 g	
	• Nova 40 W plus Dithane DG	340 g 3.00 kg	
	• Nova 40 W plus Polyram DF	340 g 3.00 kg	
	• Nova 40 W plus Maestro 80 DF	340 g 1.90 kg	
	• Nustar	100 g	
	• plus Manzate Pro-stick	3.00 kg	
	• Vanguard 75 WG	370 g	
	• Scala SC	1.00 L	
Powdery mildew	Use one of the products listed at Tight cluster to pink .		
Oriental fruit moth	• Isomate M100	250 dispensers/ha	Management of OFM is only necessary in orchards where there is a history of damage. Timing is critical for effective control. Mating disruption products are not insecticides, and will not control other pests. Initial OFM population must be low for good results. Apply to square or rectangular orchard blocks at least 4 ha. in size, before a given generation of OFM flight begins. Isomate M100: Make a second application of up to 75–80 days after initial application. Isomate Rosso: Provides control for up to 120 days. Take note of field longevity. Do not leave the crop unprotected late in the season.
	• Isomate Rosso	500 dispensers/ha	

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Tight cluster to pink			
Tentiform leafminer	• Assail 70 WP	80 g	See Table 4-10. <i>Thresholds for Tentiform Leafminer on Apples</i> , on page 69. Assail, Calypso, Actara (neonicotinoid insecticides): Apply when population is mainly in the sap feeder stage. These products are in the same chemical family and should not be used in rotation. Maximum four neonicotinoid applications per season. Repeated use of some neonicotinoids may result in mite outbreaks. Actara: Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom, and wait at least 5 days after treatment before placing beehives in or near treated fields. Intrepid or Confirm: Apply at first egg hatch. Confirm suppresses leafminer populations. Continue monitoring after application. *Pyrethroids (Pounce, Ripcord, Decis, Matador): Pyrethroids are highly toxic to beneficial insects, and may lead to outbreaks of European red mite. Pyrethroids also control spring feeding caterpillars and tarnished plant bugs. Maximum one pyrethroid application per season. Pyrethroids should be applied at first egg hatch.
	• Calypso 480 EC	145 mL	
	• Actara 25 WG	315 g	
	• Intrepid 240 F	500 mL	
	• Confirm 240 F	1.00 L	
	• *Pounce	520 mL	
	• *Decis 5 EC	250 mL	
	• *Ripcord 400 EC	250 mL	
	• *Matador 120 EC	83 mL	
Scab	Use one of the fungicides listed at Half-inch green to tight cluster .		
Powdery mildew	• Nova 40 W	340 g	Begin application at Tight cluster and continue to First summer spray . If powdery mildew was prevalent the previous year, apply fungicides beginning at Green tip . Additional sprays beyond First summer spray may be needed on susceptible varieties or if disease pressure is severe. Nova and Nustar: Should be used with an EBDC fungicide to provide subsequent protection against apple scab. Microscopic Sulphur or Kumulus: Do not use on Delicious because these products can cause an increase in red mite and scale insect populations.
	• Nustar	200 g	
	• Sovran	240 g	
	• Flint 50 WG	140 g	
	• Dikar	6.75 kg	
	• Microscopic sulphur	See label	
	• Kumulus DF	22.50 kg	
Cedar apple rust Quince rust	• Ferbam 76 WDC	see label	Include in each spray up to and including First summer spray . Ferbam: May cause russetting on Golden Delicious and other sensitive varieties. Nova: Should be used with an EBDC fungicide to provide subsequent protection against apple scab.
	• Dikar	6.75 kg	
	• Polyram DF	6.00 kg	
	• Dithane DG or Penncozeb 75 DF	6.00 kg see label	
	• Nova 40 W	340 g	
	• Flint 50 WG	140 g	
Plant bugs	• Ripcord 400 EC	250 mL	Pyrethroids (Ripcord, Matador): Are highly toxic to beneficial insects, and may lead to outbreaks of European red mite. The application of prebloom or petal fall pyrethroids to manage tentiform leafminer will suppress tarnished plant bugs.
	• Matador 120 EC	104 mL	
Spring-feeding caterpillars Green fruitworm	• Imidan 50 WP • Guthion 50 WSB or Sniper • Zolone Flo	3.75 kg see label see label 2.00 L	This spray is not necessary if a pyrethroid was applied for tentiform leafminer.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Pink			
Scab	Use one of the fungicides listed at Half-inch green to tight cluster .		
Black rot	<ul style="list-style-type: none"> Maestro 80 DF Supra Captan 80 WDG 	3.75 kg 3.75 kg	Do not use oil within 14 days of Maestro or Captan.
European red mite	<ul style="list-style-type: none"> Carzol SP 	1.10 kg	Miticides are most effective when used alone. Carzol is harsh on beneficial mite species and bees.
Rosy apple aphid	<ul style="list-style-type: none"> Assail 70 WP Zolone Flo 	120 g 2.00 L	Preferred time for control. See Table 9-4, <i>Relative Toxicity of Pesticides to Honeybees</i> , on page 193. Assail : Maximum 4 neonicotinoid applications per season. Repeated use of some neonicotinoids may result in mite outbreaks.
Bloom			
DO NOT APPLY INSECTICIDES WHILE APPLE TREES ARE IN BLOOM. SEE BEE POISONING ON PAGE 192.			
Scab	<ul style="list-style-type: none"> Supra Captan 80 WDG or Maestro 80 DF Polyram DF Dikar Manzate Pro-stick or Dithane DG or Penncozeb 75 DF Nova 40 W plus Dithane DG Nova 40 W plus Polyram DF Nova 40 W plus Maestro 80 DF Nustar plus Manzate Pro-stick Flint 50 WG Sovran 	3.75 kg 3.75 kg 6.00 kg 6.75 kg 6.00 kg 6.00 kg see label 340 g 3.00 kg 340 g 3.00 kg 340 g 1.90 kg 100 g 3.00 kg 140 g 240 g	Sovran, Flint, Nova, Nustar : Do not use earlier than Tight cluster . See Table 2-8, <i>Fungicide/Bactericide Groupings Based on Sites of Action</i> , on page 16. After last application of Sovran, Flint, Nova or Nustar tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications. Check label for details. Do not use Nova, Nustar, Flint or Sovran once apple scab is present. Use of these products as eradicants may result in the development of fungicide resistance.
Fire blight	<ul style="list-style-type: none"> Streptomycin 17 	600 g/1,000 L	Sprays are most effective when applied dilute (high volumes of water) prior to a wetting period. Use alone for best results. Streptomycin 17 is UV light sensitive and is only effective for 2–3 days. Re-application is needed after 2–3 days if warm, wet conditions (above 20°C) prevail. 2–3 sprays during bloom may be required for fire blight control. Maximum three applications per season.
Late Bloom/Early Petal Fall			
Fire blight (Suppression of shoot blight stage)	<ul style="list-style-type: none"> Apogee 	1.35 kg	Apogee : A plant growth regulator that reduces vegetative growth in the tree, making the tree less susceptible to fire blight infections of shoots. Apogee has no impact on blossom blight or the fire blight bacteria. Apogee should be applied in late bloom or early petal fall when shoots are 2.5 to 5.5 cm long. Accurate timing of application is critical. Apogee will help suppress fire blight infections from this point on. Re-apply spray 14–21 days later. In plantings with low vigour, a reduction in shoot growth caused by the high rate of Apogee for fire blight suppression may be undesirable. For more information on the use of Apogee refer to <i>Vegetative growth control in apples</i> , on page 85.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Petal fall (Calyx) when most petals have fallen			
Scab	Use one of the fungicides recommended at Bloom .		
Black rot	Use one of the fungicides listed at Pink .		
Tentiform leafminer	<ul style="list-style-type: none"> • Agri-Mek 1.9% EC • Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Calypso 480 EC • *Pounce • *Decis 5 EC • *Ripcord 400 EC • *Matador 120 EC 	750 mL 380 mL 380 mL 80 g 315 g 145 mL 520 mL 250 mL 250 mL 83 mL	<p>See Table 4-10. <i>Thresholds for Tentiform Leafminer on Apples</i>, on page 69.</p> <p>Agri-Mek and Pyrethroids: Apply for tentiform leafminer when the first sapfeeders are present.</p> <p>Agri-Mek: Do not apply later than 21 days after petal fall. Apply with 10 L of Superior 70 Oil and a minimum of 1,000 L of water per ha. Agri-Mek plus oil may cause russetting to Golden Delicious and other light-skinned cultivars. Do not use Agri-Mek plus oil within 14 days of Captan or Maestro application. Maximum one application Agri-Mek per season. Agri-Mek plus oil is best applied alone. Also controls ERM and TSSM.</p> <p>Admire/Alias, Assail, Actara, Calypso: Apply neonicotinoid insecticides when population is mainly in the sap feeder stage. These products are in the same chemical family and should not be used in rotation. These products will also control other insects at this timing. Note that some neonicotinoids are toxic to bees.</p> <p>Actara: Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom, and wait at least 5 days after treatment before placing beehives in or near treated fields.</p> <p>Maximum four neonicotinoid applications per season.</p> <p>*Pyrethroids (Pounce, Ripcord, Decis, Matador): Pyrethroids are highly toxic to beneficial insects, and may lead to outbreaks of European red mite. In years where leafminer egg hatch is delayed, a pyrethroid can be applied at petal fall when first sap-feeding mine is detected. This treatment also controls tarnished plant bug and spring feeding caterpillars. Maximum one pyrethroid application per season.</p>
Rosy apple aphid	<ul style="list-style-type: none"> • Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Zolone Flo 	230 mL 230 mL 120 g 160 g 2.00 L	<p>Admire /Alias, Assail, Actara: Applied at this time also control other insects. These products are in the same chemical family and should not be used in rotation. Repeated use of some neonicotinoids may result in mite outbreaks.</p> <p>Actara: Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom, and wait at least 5 days after treatment before placing beehives in or near treated fields. Maximum four neonicotinoid applications per season.</p>
Mullein leaf bug	<ul style="list-style-type: none"> • Calypso 480 EC • Actara 25 WG • Admire 240 F or Alias 240 SC • Diazinon 50 W 	290 mL 315 g 380 mL 380 mL 3.25 kg	<p>Timing of sprays is important.</p> <p>Neonicotinoids (Actara/Calypso/Admire/Alias): Applied at this time also control green apple aphid, rosy apple aphid, white apple leafhopper, and tentiform leafminer. Repeated use of neonicotinoids may result in mite outbreaks. Maximum four neonicotinoid applications per season.</p>
Oystershell scale San Jose scale	<ul style="list-style-type: none"> • Guthion 50 WSB or Sniper 	see label see label	<p>Apply when the crawlers are active.</p>

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Plum curculio	<ul style="list-style-type: none"> Actara 25 WG Calypso 480 EC Imidan 50 WP Zolone Flo Guthion 50 WSB or Sniper Surround WP 	385 g 440 mL 3.75 kg 3.00 L see label see label 50.0 kg	<p>Actara/Calypso: These products are in the same chemical family and should not be used in rotation. Repeated use of some neonicotinoids may result in mite outbreaks.</p> <p>Do not use Calypso/Actara in border sprays. Actara and Calypso also have activity against mullein bug and tentiform leafminer.</p> <p>Maximum four neonicotinoid applications per season. Research indicates that application of Calypso/Actara at petal fall plus 3 days is the optimal timing for plum curculio. However if monitoring indicates plum curculio is in the orchard prior to this timing, then insecticides should be applied at petal fall.</p> <p>Actara: Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom, and wait at least 5 days after treatment before placing beehives in or near treated fields.</p> <p>Guthion, Sniper, Imidan, and Zolone: Will provide subsequent control of some caterpillars. These products should be applied immediately at petal fall, or when monitoring indicates plum curculio is in the orchard.</p> <p>Surround: Must be applied before plum curculio are present in orchard. Make two applications, 7 days apart, at 50 kg/ha, to establish a base layer. Continue at 7–14 day intervals, using a reduced rate of 25 kg/ha, to maintain even coverage of developing fruits. Do not use Surround in border sprays. See <i>Particle film technology</i> on page 10.</p>
European apple sawfly	<ul style="list-style-type: none"> Guthion 50 WSB or Sniper 	see label see label	<p>Apply as a special spray to orchards where there has been a history of damage.</p>

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
European red mite	• Agri-Mek 1.9% EC	750 mL	<p>See Table 4-8. <i>Thresholds for European Red Mite and Two-spotted Spider Mite on Apples</i>, on page 68. Do not apply any miticide more than once per season. Thorough coverage is essential for good control with miticides. To prevent development of pesticide resistance, miticides should be rotated with products from different families. See Table 2-7. <i>Insecticide and Miticide Groups Based on Sites of Action</i>, on page 15.</p> <p>Agri-Mek: Apply when mites are in the nymph stage, no later than 21 days after petal fall. Apply with 10 L Superior 70 Oil and a minimum of 1,000 L of water per ha. Agri-Mek plus oil may cause russetting to Golden Delicious and other light-skinned varieties. Do not use Agri-Mek plus oil within 14 days of a Captan or Maestro application. Ideally, alternate yearly with other early season miticides (e.g., Superior 70 Oil, Apollo). Agri-Mek also controls tentiform leafminer.</p> <p>Envidor: Has slow activity and results may not be apparent for up to 1 week. Envidor is effective in managing rust mites.</p> <p>Acramite and Envidor: Should be applied when there are 5 or more active mites per leaf.</p> <p>Apollo: Kills mite eggs. Apply when mites are mostly in the egg stage and before there are more than 3 active mites per leaf. Thorough coverage is essential for good control. Apply Apollo alone in a minimum of 1,100 L of water per ha.</p> <p>Carzol: Harsh on beneficial insects, mites and bees.</p>
	• Acramite 50 WS	851 g or 3.75 pouches	
	• Envidor 240 SC	750 mL	
	• Kanemite 15 SC	2.1 L	
	• Apollo SC	300 mL	
	• Carzol SP	1.10 kg	
Blister spot	• Aliette WDC	2.00 kg	<p>Begin applications at petal fall with 1–2 subsequent sprays at 7 day intervals. Do not mix with copper compounds. Maximum three applications per season.</p>
Obliquebanded leafroller	• Success 480 SC	182 mL	<p>When applied for leafroller control, these products also control other caterpillars.</p> <p>OBLR are resistant to OP insecticides in most commercial apple orchards. Cross-resistance to pyrethroids and Confirm has been documented in some Ontario OBLR populations. Cross-resistance with OP insecticides and Intrepid has been observed in other apple growing regions, but this has not been demonstrated in Ontario. Avoid treating sequential generations with the products from the same chemical family. See Table 2-7. <i>Insecticide and Miticide Groups Based on Sites of Action</i>, on page 15.</p> <p>Success/Entrust: Monitor populations and re-apply as necessary on a 7–10 day schedule. Spray solution should be above pH 6.0.</p> <p>*B.t. products (Dipel, Foray, Bioprotec): Make two applications at 5–7 day intervals if activity of the larvae is extended. For best results when using B.t. products, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days.</p> <p>Intrepid or Confirm: Accurate timing these products is important. See label for specific timing. Intrepid will also manage leafminers and oriental fruit moth when applied at this time.</p>
	• Entrust 80 W	109 g	
	• *Dipel 2X DF	1.12 kg	
	or *Foray 48BA	2.80 L	
	or *Bioprotec CAF	4.00 L	
	• Intrepid 240 F	750 mL	
	• Confirm 240 F	1.00 L	

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Oriental fruit moth	• Intrepid 240 F	1.00 L	<p>Apply as a special spray to orchards where there is a history of damage. Timing is critical for effective control; use monitoring results to adjust spray timing. Begin applications at peak egg hatch based on pheromone trap counts and degree-days.</p> <p>Intrepid: Application at this time will provide subsequent control of OBLR .</p> <p>Rimon: Use for first generation only. Rimon applied at this time will also control codling moth (CM), however a repeat application 10–14 days later will be necessary for CM control. See label for additional information on rates and volumes. Do not allow Rimon to drift onto grapes as leaf spotting may occur.</p> <p>Neonicotinoids (Assail, Calypso): When applied at this time will also control mullein bug and tentiform leafminer. Assail and Calypso are in the same chemical family and should not be used in rotation. Repeated use of some neonicotinoids may result in mite outbreaks. Maximum four neonicotinoid applications per season.</p> <p>*Pyrethroids (Decis): Pyrethroids are highly toxic to beneficial insects and may lead to outbreaks of European red mite. Use only as a last resort. Maximum 1 pyrethroid per season.</p>
	• Assail 70 WP	240 g	
	• Calypso 480 EC	440 mL	
	• Rimon 10 EC	1.4 L/1,000 L	
	• *Decis 5 EC	250 mL	
Codling moth	• Rimon 10 EC	1.4 L/1,000L	<p>Rimon: Has a unique mode of action and should be applied earlier than other products for codling moth. Apply Rimon at petal fall and re-apply 10–14 days later. Use for first generation only. See label for additional information on rates and volumes. Do not allow Rimon to drift onto grapes as leaf spotting may occur. The application of Rimon at this time will provide subsequent control of OBLR and OFM.</p>
Powdery mildew	Use one of the fungicides listed at Tight cluster to pink .		
First summer spray (7–14 days after Petal fall (Calyx))			
Scab	Use one of the fungicides recommended at Bloom . An extra scab spray may be required between Petal fall (Calyx) and First summer spray . See <i>Control of apple scab under adverse weather conditions</i> on page 70.		
Plum curculio	Use one of the insecticides listed under Petal fall (Calyx) .		
Fire blight	• Streptomycin 17	600 g/1,000 L	Apply to control shoot blight especially if blossom blight has occurred.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
European red mite	• Agri-Mek 1.9% EC	750 mL	<p>See Table 4-8. <i>Thresholds for European Red Mite and Two-spotted Spider Mite on Apples</i>, on page 68. Do not apply any miticide more than once per season. Thorough coverage is essential for good control with miticides. To prevent development of pesticide resistance, miticides should be rotated with products from different families see Table 2-7. <i>Insecticide and Miticide Groups Based on Sites of Action</i>, on page 15.</p> <p>Agri-Mek: Apply when mites are in the nymph stage, no later than 21 days after petal fall. Apply with 10 L of Superior 70 Oil and a minimum of 1,000 L of water per ha. Agri-Mek plus oil may cause russetting to Golden Delicious and other light-skinned cultivars. Do not use Agri-Mek plus oil within 14 days of Captan or Maestro application. Ideally, alternate yearly with other early season miticides (e.g., Superior 70 Oil, Apollo). Agri-Mek also controls tentiform leafminer.</p> <p>Envidor: Effective in managing rust mites. Activity is slow; control may not be apparent for up to 1 week.</p> <p>Acramite and Envidor: Should be applied when there are 5 or more active mites per leaf.</p> <p>Apollo: Apply no later than 14 days after petal fall. Apollo kills mite eggs. Apply when mites are mostly in the egg stage and before there are more than 3 active mites per leaf. Apply Apollo alone in a minimum of 1,100 L of water per ha.</p> <p>See <i>Pest Resistance to Insecticides, Fungicides, Miticides</i> on page 13.</p>
	• Acramite 50 WS	851 g or 3.75 pouches	
	• Envidor 240 SC	0.75 L	
	• Kanemite 15 SC	2.1 L	
	• Apollo SC	300 mL	
Two-spotted spider mite	• Agri-Mek 1.9% EC	750 mL	<p>See Table 4-8. <i>Thresholds for European Red Mite and Two-spotted Spider Mite on Apples</i>, on page 68. Do not apply any miticide more than once per season. Thorough coverage is essential for good control with miticides. To prevent development of pesticide resistance, miticides should be rotated with products from different families. See Table 2-7. <i>Insecticide and Miticide Groups Based on Sites of Action</i>, on page 15.</p> <p>Agri-Mek: Apply when mites are in the nymph stage, no later than 21 days after petal fall. Apply with 10 L of Superior 70 Oil and a minimum of 1,000 L of water per ha. Agri-Mek plus oil may cause russetting to Golden Delicious and other light-skinned cultivars. Do not apply within 14 days of Captan or Maestro application. Ideally, alternate yearly with other early season miticides (e.g., Superior 70 Oil, Apollo). Agri-Mek also controls tentiform leafminer.</p> <p>Envidor: Effective in managing rust mites. Activity is slow; control may not be apparent for up to 1 week.</p> <p>Acramite and Envidor: Should be applied when there are 5 or more active mites per leaf.</p> <p>Apollo: Apply no later than 14 days after petal fall. Apollo kills mite eggs. Apply when mites are mostly in the egg stage and before there are more than 3 active mites per leaf. Thorough coverage is essential for good control. Apply Apollo alone in a minimum of 1,100 L of water per ha.</p> <p>See <i>Pest Resistance to Insecticides, Fungicides, Miticides</i> on page 13.</p>
	• Acramite 50 WS	567 g or 2.5 pouches	
	• Envidor 240 SC	0.75 L	
	• Kanemite 15 SC	2.1 L	
	• Apollo SC	300 mL	

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Rosy apple aphid	<ul style="list-style-type: none"> • Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Zolone Flo 	230 mL 230 mL 120 g 160 g 2.00 L	Admire/Alias, Assail, or Actara: When applied at this time also control green apple aphid and white apple leafhopper. Maximum four neonicotinoid applications per season. Repeated use of neonicotinoids may result in mite outbreaks.
Powdery mildew	Use one of the fungicides listed under Tight cluster to pink .		
Blister spot	<ul style="list-style-type: none"> • Copper 53 W • Aliette WDG 	3.00 kg 2.00 kg	Copper 53 W: To reduce the incidence of blister spot lesions on Crispin and other sensitive varieties, apply up to three applications beginning 10 days after petal fall. Use hydrated lime as a safener (to reduce the risk of phytotoxicity) at a rate of 6 kg per 1 kg of Copper 53 W per 1,000 L of water. Apply 3,000 L of water per ha. Aliette: Begin applications at petal fall with 1–2 subsequent sprays at 7 day intervals. Do not mix with copper compounds. Maximum three applications per season.
Oriental fruit moth	<ul style="list-style-type: none"> • Isomate M 100 • Isomate Rosso 	250 dispensers/ha 500 dispensers/ha	Refer to mating disruption comments listed under Half-inch green to tight cluster . Make a second application of Isomate M 100 75–80 days following the first application. Isomate Rosso: Will provide control for up to 120 days.
Codling moth (1 st generation)	<ul style="list-style-type: none"> • Intrepid 240 F • Confirm 240 F • Assail 70 WP • Calypso 480 EC • Imidan 50 WP • Guthion 50 WSB or Sniper • Zolone Flo 	1.00 L 1.00 L 170 g 440 mL 3.75 kg see label see label 2.00 L	Timing is critical; use pheromone traps to time sprays. Place traps in orchards at bloom. OP insecticides (Imidan, Guthion, Sniper, Zolone): Apply for 1 st generation codling moth at 100 DDC (base 11°C). Intrepid and Confirm: Apply Intrepid/Confirm 2–3 days earlier than OP insecticides. These products also suppress leaf-feeding caterpillars, but do not control apple maggot. Border sprays are not recommended with these products. Intrepid residuals last 14+ days. Assail and Calypso: Apply 1–2 days earlier than OP insecticides. Calypso provides subsequent control of plum curculio and apple maggot. Border sprays are not recommended with Calypso and Assail. Repeated use of neonicotinoids may result in mite outbreaks. Calypso/Assail residues last 10–14 days. Maximum four neonicotinoid applications per season. Guthion and Sniper: Also control scale crawlers. Zolone: Also controls aphids. Not all of the products registered for codling moth provide subsequent control of plum curculio and apple maggot.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Subsequent summer sprays			
Scab	Until the end of the primary scab season use one of the fungicides recommended at Bloom . For summer (secondary) scab control, use one of the following:		
	<ul style="list-style-type: none">Supra Captan 80 WDG or Maestro 80 DF	3.75 kg (1.9) 3.75 kg (1.9)	If scab is controlled in your orchard use the lower rate given in brackets. Do not apply Polyram, Dikar, Manzate, Dithane or Penncozeb within 45 days of harvest.
	<ul style="list-style-type: none">Dikar WPPolyram DFManzate Pro-stick or Dithane DG or Penncozeb 75 DF	6.75 kg 6.00 kg (4.5) 6.00 kg (5.0) 6.00 kg (4.5) see label	
Sooty blotch Fly speck	<ul style="list-style-type: none">Supra Captan 80 WDG or Maestro 80 DF	3.75 kg 3.75 kg	
	<ul style="list-style-type: none">Flint 50 WG	140 g	
Codling moth	<ul style="list-style-type: none">Intrepid 240 FConfirm 240 FAssail 70 WPCalypso 480 ECImidan 50 WPGuthion 50 WSB or SniperZolone Flo	1.00 L 1.00 L 170 g 440 mL 3.75 kg see label see label 2.00 L	Timing is critical for effective control. Use pheromone traps to time sprays. Not all of the products registered for codling moth provide subsequent control of apple maggot. OP insecticides (Imidan, Guthion, Sniper, Zolone): Apply for 2 nd generation codling moth at 700 DDC (base 11°C). Intrepid and Confirm: Accurate timing of Confirm/Intrepid is important. Apply 2–3 days earlier than OP insecticides. Border sprays are not recommended. These products also suppress leaf-feeding caterpillars, but do not control apple maggot. Intrepid residues last 14+ days. Assail and Calypso: Apply 1–2 days earlier than OP insecticides. Calypso provides subsequent control of apple maggot. Border sprays are not recommended. Repeated use of neonicotinoids may result in mite outbreaks. Assail and Calypso residues last 10–14 days. Maximum four neonicotinoid applications per season. Guthion and Sniper: Also control scale crawlers. Zolone: Also controls aphids.
Oriental fruit moth	<ul style="list-style-type: none">Isomate M 100Isomate Rosso	250 dispensers/ha 500 dispensers/ha	Refer to mating disruption comments listed under Half-inch green to tight cluster . Make a second application of Isomate M 100, 75–80 days following first application. Isomate Rosso provides control for up to 120 days.
Apple maggot	<ul style="list-style-type: none">Imidan 50 WPGuthion 50 WSB or SniperZolone FloDiazinon 50 WCalypso 480 ECSurround WP	3.75 kg see label see label 3.00 L see label 440 mL 50.00 kg	Use trap catches to time the first spray. Make subsequent applications at 14–21 day intervals or as required based on monitoring. OP's (Imidan, Guthion/Sniper, Zolone, Diazinon) and Calypso: Apply 7 days after the first adult maggot is caught on a sticky board. OP insecticide residues last approximately 18–21 days. Calypso residue lasts 14 days. Maximum four neonicotinoid applications per season. Repeated use of neonicotinoids may result in mite outbreaks. Surround: Begin applications well before first maggot flies are trapped in commercial orchards, and continue at 7–14 day intervals to maintain even coverage of fruit as long as flies continue to be captured. Use 50 kg/ha for the first two applications of the season, continue at 25 kg/ha. See <i>Particle film technology</i> on page 10. Calypso or Surround: Not recommended for use as border sprays.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Special summer sprays			
Blister spot	<ul style="list-style-type: none"> Copper 53 W Aliette WDG 	3.00 kg 2.00 kg	See comments on blister spot control under First summer spray .
Green apple aphid Rosy apple aphid	<ul style="list-style-type: none"> Admire 240 F or Alias 240 SC Assail 70 WP Zolone Flo Diazinon 50 W Thiodan 50 WP or Thionex 50 W 	230 mL 230 mL 120 g 2.00 L see label 4.50 kg 4.50 kg	<p>Zolone and Diazinon: Also control woolly apple aphid, codling moth and apple maggot.</p> <p>Admire/Alias and Assail: Also control white apple leafhopper. Maximum four neonicotinoid applications per season. Repeated use of neonicotinoids may result in mite outbreaks.</p> <p>Thiodan and Thionex: Also control white apple leafhopper.</p>
Woolly apple aphid	<ul style="list-style-type: none"> Diazinon 500 E Malathion 25 W Zolone Flo 	see label see label 2.00 L	<p>Use high volumes of water and ensure spray contacts trunk and scaffold limbs. Repeat application in 14 days if woolly apple aphid is still present.</p> <p>Zolone: Effective only if used on a regular basis.</p>
White apple leafhopper	<ul style="list-style-type: none"> Admire 240 F or Alias 240 SC Calypso 480 EC Sevin XLR Carzol SP Thionex 50 W 	200 mL 200 mL 145 mL 3.10 L 1.10 kg 2.60 kg	<p>Spray when nymphs are present (2–5 per leaf). There are 2 generations of nymphs per season, in mid-June and early August. Control of adults is very difficult.</p> <p>Admire/Alias: When applied for first generation, also controls green apple aphid and rosy apple aphid.</p> <p>Assail: Applied at a rate of 120 g/ha for aphids will control leafhoppers.</p> <p>Repeated use of neonicotinoids may result in mite outbreaks. Maximum four neonicotinoid applications per season.</p>
Potato leafhopper	<ul style="list-style-type: none"> Thionex 50 W Calypso 480 EC 	2.60 kg 145 mL	Assail: Applied at a rate of 120 g/ha for aphids will also control leafhoppers.
Tentiform leafminer	<ul style="list-style-type: none"> Admire 240 F or Alias 240 SC Assail 70 WP Calypso 480 EC *Pounce *Decis 5 EC *Ripcord 400 EC *Matador 120 EC 	380 mL 380 mL 80 g 290 mL 520 mL 250 mL 250 mL 83 mL	<p>See Table 4-10. <i>Thresholds for Tentiform Leafminer on Apples</i>, on page 69.</p> <p>Admire/Alias, Assail and Calypso: Apply when populations are mainly in the sap-feeder stage.</p> <p>Calypso: Note rate change from 1st to 2nd generation. Maximum four neonicotinoid applications per season. Repeated use of neonicotinoids may result in mite outbreaks.</p> <p>*Pyrethroids: Use is discouraged for summer generations of tentiform leafminer. Pyrethroids are highly toxic to beneficial insects and may lead to outbreaks of European red mite. These products do not control larvae within the mines.</p>
Dogwood borer Apple bark borer	<ul style="list-style-type: none"> Pounce plus Superior Oil 	22 mL/100 L water with 2 L oil	Soak the trunk. Make two applications at 2–3 week intervals when adults are flying (late June–early August).

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Obliquebanded leafroller	• Success 480 SC	182 mL	<p>Place pheromone traps in orchards by June to monitor adult populations. Insecticide populations for summer generation larvae should be applied at 240–280 DDC after first sustained moth catch (base 6.1°C). When applied for leafroller control, these products also control other leaf-feeding caterpillars.</p> <p>OBLR are resistant to OP insecticides in most commercial apple orchards. Cross-resistance to pyrethroids and Confirm has been documented in some Ontario OBLR populations. Cross-resistance with OP insecticides and Intrepid has been observed in other apple growing regions, but has not been demonstrated in Ontario. Avoid treating sequential generations with the products from the same chemical family. See Table 2-7, <i>Insecticide and Miticide Groups Based on Sites of Action</i>, on page 15.</p> <p>Success/Entrust: Monitor populations and re-apply as necessary on a 7–10 day schedule. Maximum three applications per season. Spray solution should be above pH 6.0.</p> <p>Intrepid/Confirm: Note these products provide suppression of OBLR at this timing. Apply a second spray 10–14 days after the first application. Accurate timing is important. See label for specific timing. Maximum two applications per season.</p> <p>*B.t. products: Make two applications of B.t. products at 5–7 day intervals if activity of the larvae is extended. For best results acidify spray mix to below pH 7.0 and apply at dusk or on overcast days.</p>
	• Entrust 80 W	109 g	
	• *Dipel 2X DF or *Foray 48BA or *Bioprotec CAF	1.12 kg 2.80 L 4.00 L	
	• Intrepid 240 F	750 mL	
	• Confirm 240 F	1.00 L	
Oriental fruit moth	• Assail 70 WP	240 g	<p>Apply as a special spray to orchards where there has been a history of damage. Timing is critical for effective control; use monitoring results to adjust spray timing. Begin applications at peak egg hatch based on pheromone trap counts and degree-days. Apply sprays 6–10 days after upswing in the moth flight for the first generation and 3–6 days after the upswing in moth flight for subsequent generations.</p> <p>Rotate between products in different chemical families to deter the development of pesticide resistance. See Table 2-7, <i>Insecticide and Miticide Groups Based on Sites of Action</i>, on page 15.</p> <p>*Pyrethroids: Highly toxic to beneficial insects and may lead to outbreaks of European red mite. Use only as a last resort.</p>
	• Calypso 480 SC	440 mL	
	• *Decis 5 EC	250 mL	
	• Intrepid 240 F	1.00 L	

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
European red mite	<ul style="list-style-type: none">• Pyramite or Nexter• Acramite 50 WS• Envidor 240 SC• Kanemite 15 SC• Kelthane 50 W• Carzol SP	<div>300 g</div> <div>300 g</div> <div>851 g or 3.75 pouches</div> <div>0.75 L</div> <div>2.10 L</div> <div>3.25 kg</div> <div>1.10 kg</div>	<p>Thorough coverage is essential for good control with miticides. To prevent development of pesticide resistance, miticides should be rotated with products from different families see Table 2-7. <i>Insecticide and Miticide Groups Based on Sites of Action</i>, on page 15.</p> <p>Use established spray thresholds to time miticide applications. See Table 4-9. <i>Activity of Miticides Registered on Apple and/or Pear in Ontario</i>, on page 68. Miticides are best used alone. Use a minimum of 1,000 L/ha of water when applying summer miticides.</p> <p>Use each miticide only once per season to delay development of resistance. See <i>Pest Resistance to Insecticides, Fungicides, Miticides</i> on page 13.</p> <p>Envidor, Pyramite/Nexter or Kelthane: Will also control rust mite.</p> <p>Pyramite/Nexter: Most effective against immature stages (but not eggs).</p> <p>Envidor: Has slow activity; control may not be apparent for up to 1 week.</p> <p>Carzol: Harsh on beneficial mite species.</p>
Two-spotted spider mite	<ul style="list-style-type: none">• Pyramite or Nexter• Kelthane 50 W• Carzol SP• Acramite 50 WS• Envidor 240 SC• Kanemite 15 SC	<div>600 g</div> <div>600 g</div> <div>3.25 kg</div> <div>1.10 kg</div> <div>567 g or 2.5 pouches</div> <div>0.75 L</div> <div>2.10 L</div>	<p>Use established spray thresholds to time miticide applications. See Table 4-9. <i>Activity of Miticides Registered on Apple and/or Pear in Ontario</i>, on page 68. Miticides are best used alone. Use a minimum of 1,000 L/ha of water when applying summer miticides. Apply each miticide only once per season to delay development of resistance. See <i>Pest Resistance to Insecticides, Fungicides, Miticides</i> on page 13.</p> <p>Envidor, Pyramite/Nexter or Kelthane: Will also control rust mite.</p> <p>Pyramite/Nexter: Most effective against immature stages (but not eggs).</p> <p>Envidor: Has slow activity; control may not be apparent for up to 1 week.</p> <p>Carzol: Harsh on beneficial mite species.</p>
Japanese beetle	<ul style="list-style-type: none">• Imidan 50 WP	<div>3.75 kg</div>	<p>Japanese beetles have recently become a problem in some Ontario orchards, especially in young plantings of Honeycrisp. If Japanese beetles cause economic damage, insecticide sprays may be necessary. For information on managing this pest contact your local crop consultant.</p>
Pinpoint and storage scab	Use one of the fungicides recommended for secondary scab in Subsequent summer sprays . Do not use fungicides closer than the stated interval to harvest. See Table 4-7. <i>Products Used on Apples</i> , on page 66.		
Preharvest sprays			
Botrytis grey mould Penicillium storage diseases (suppression)	<ul style="list-style-type: none">• Scala SC	<div>2.00 L</div>	<p>Scala: Apply 2 weeks before harvest.</p> <p>Captan and Maestro: Summer applications provide some protection against storage rots.</p>
Postharvest treatment			
Blue mould Grey mould	<ul style="list-style-type: none">• Mertect SC• Scholar 50 WP	<div>0.50 L/500 L</div> <div>227 g of product in 378 L of water.</div>	<p>Mertect: Continuous agitation is required. Follow label instructions. Does not control blue mould (<i>Penicillium</i>) or grey mould (<i>Botrytis</i>), that are resistant to benzimidazole fungicides.</p> <p>Scholar: For use in dip tank or drencher. Treats up to 90,000 kg of fruit. For dip treatments, dip fruit for approximately 30 seconds and allow fruit to drain.</p>

Guidelines for Protecting Non-Bearing Apple Plantings

The following program is designed to offer limited protection when needed for newly planted trees. It is not intended for protection of bearing orchards. To minimize pest pressure, remove neglected fruit trees in the area and control weeds. Alternate materials are available as shown in the calendar for bearing fruits.

Diseases and Insects	Materials	Comments
Early spring		
Phytophthora collar rot	• Ridomil Gold 480 SL	
First spray		
Powdery mildew	<ul style="list-style-type: none"> • Nova 40 W • Nustar • Sovran • Flint 50 WG • Dikar 	
Scab	<ul style="list-style-type: none"> • Dikar • Manzate Pro-stick or Dithane DG or Penncozeb 75 DF • Polyram DF • Supra Captan 80 WDG or Maestro 80 DF 	When green tissue shows. Repeat at 7–10 day intervals if wet weather occurs until late June.
Prebloom		
Tentiform leafminer	<ul style="list-style-type: none"> • Assail 70 WP or Alias 240 SC • Actara 25 WG • Calypso 480 EC • Confirm 240 F • Intrepid 240 F • *Pounce • *Decis 5EC • *Ripcord 400 EC • *Matador 120 EC 	* Do not apply pyrethroids more than once per season. Pyrethroids are highly toxic to beneficial insects and may lead to outbreaks of European red mite.
Leaf-feeding caterpillars	<ul style="list-style-type: none"> • Imidan 50 WP • Guthion 50 WSB or Sniper • Zolone Flo 	Before blossoms open in adjacent bearing orchards. Apply when caterpillars are small. Include with a fungicide spray. Not necessary if a pyrethroid was used for tentiform leafminer.
Bloom		
Fire blight	• Streptomycin 17	Avoid overstimulating growth.
Post-bloom		
Leaf curling midge	• Ripcord 400 EC	
Summer sprays		
Leaf-feeding insects	<ul style="list-style-type: none"> • Imidan 50 WP • Guthion 50 WSB or Sniper • Zolone Flo 	This spray will also control potato leafhopper.

Diseases and Insects	Materials	Comments
Aphids	<ul style="list-style-type: none"> • Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Thiodan 50 WP or Thionex 50 W • Diazinon 50 W 	Spray if insects become abundant at any time.
White apple leafhopper	<ul style="list-style-type: none"> • Admire 240 F or Alias 240 SC • Assail 70 WP • Calypso 480 EC • Thionex 50 W 	
Potato leafhopper	<ul style="list-style-type: none"> • Assail 70 WP • Calypso 480 EC • Thionex 50 W • Thiodan 50 WP 	
Tentiform leafminer	<ul style="list-style-type: none"> • Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Calypso 480 EC • Vydate L 	Vydate is very toxic to applicator. Timing is critical. If mines are visible on underleaf surface, consult crop consultant.
Mites	<ul style="list-style-type: none"> • Pyramite or Nexter • Acramite 50 WS • Envidor 240 SC • Kanemite 15 SC • Kelthane 50 W • Carzol SP 	Check foliage frequently for mite injury. Spray if more than 10 mites per leaf are observed or at first sign of leaf bronzing.
Buffalo treehopper		Follow clean cultivation practices or remove legumes from cover crop.
Phytophthora collar rot	• Ridomil Gold 480 SL	
Root lesion nematode	See <i>Nematodes</i> on page 14, and <i>Nematode suppression after planting</i> on page 19.	

TABLE 4-7. Products Used on Apples

Use this table as a guide, but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between when you apply the pesticide and when you work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume that the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labeled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Chemical family or sub-group	Preharvest interval	Minimum re-entry period	Maximum number of applications per season
Acramite 50 WS	bifenazate	carbазate	7 days	12 hours	1
Actara 25 WG	thiamethoxam	neonicotinoid	60 days	12 hours	2; (max 770 g/ha)
Admire 240 F	imidacloprid	neonicotinoid	7 days	24 hours	2
Agri-Mek 1.9% EC	abamectin	avermectin	28 days		1
Alias 240 SC	imidacloprid	neonicotinoid	7 days	24 hours	2
Aliette WDG	fosetyl al	phosphonate	30 days		3
Apogee	prohexadione calcium		45 days	12 hours	4; (max. 5.4 kg/ha)
Apollo SC	clofentezine	tetrazine	No later than 14 days after petal fall		1
Assail 70 WP	acetamiprid	neonicotinoid	7 days	12 hours	4
Bioprotec CAF	<i>Bacillus thuringiensis</i>	B.t. microbial	1 day		
Calypto 480 EC	thiacloprid	neonicotinoid	30 days	12 hours	3 or 875 mL/ha
Carzol SP	formetanate hydrochloride	carbamate	1 day		4.48 kg/ha after calyx
Confirm 240 F	tebufenozide	ecdysone agonist	14 days		4
Copper 53 W	tri-basic copper sulphate	inorganic	30 days		3
Decis 5 EC	deltamethrin	synthetic pyrethroid	1 day		3
Diazinon 50 W	diazinon	organophosphate	14 days		
Dikar	mancozeb + dinocap	dithiocarbamate	45 days	48 hours	
Dipel 2X DF	<i>Bacillus thuringiensis</i>	B.t. microbial	1 day		
Dithane DG	mancozeb	dithiocarbamate	45 days		
Entrust 80 W	spinosad	spinosyn	7 days	when dried	3
Envior 240 SC	spirodiclofen	tetronic acid derivative	7 days	12 hours	1
Ferbam 76 WDG	ferbam	dithiocarbamate	7 days		
Flint 50 WG	trifloxystrobin	strobilurin	14 days	12 hours except 4 days for hand-thinning	4; (max 770 g/ha)
Foray 48 BA	<i>Bacillus thuringiensis</i>	B.t. microbial	1 day		
Guthion 50 WSB	azinphosmethyl	organophosphate	14 or 21 days depending on rate	14 days	4
Imidan 50 WP	phosmet	organophosphate	1 day		
Intrepid 240 F	methoxyfenozide	ecdysone agonist	14 days		2 L product/ha
Kanemite 15 SC	acequinocyl	quinolinone	14 days	12 hours	2; (max 4.1 L/ha)
Kelthane 50 W	dicofol	diphenylethane	7 days		1

* See label for specifics. May be more or less for some tasks.

TABLE 4-7. Products Used on Apples (cont'd)

Product name	Common name	Chemical family or sub-group	Preharvest interval	Minimum re-entry period	Maximum number of applications per season
Kumulus DF	sulphur	inorganic	1 day		
Maestro 80 DF	captan	phthalimide	7 days	48 hours	
Malathion 25 W	malathion	organophosphate	3 days		
Manzate Pro-stick	mancozeb	dithiocarbamate	45 days		
Matador 120 EC	cyhalothrin lambda	synthetic pyrethroid	7 days	24 hours	3
Microscopic Wettable Sulphur	sulphur	inorganic	1 day		
Nexter	pyridaben	pyridazinone	25 days	24 hours	2
Nova 40 W	mycobutanil	triazole (DMI)	14 days		6
Nustar	flusilazole	DMI	77 days	12 hours	4
Penncozeb 75 DF	mancozeb	dithiocarbamate	45 days	24 hours	
Polyram DF	metiram	dithiocarbamate	45 days		
Pounce	permethrin	pyrethroid	7 days		
Pyramite	pyridaben	pyridazinone	25 days	24 hours	2
Ridomil Gold 480 SL	metalaxyl-m	acylamine	non-bearing only		3
Rimon 10 EC	novaluron	benzoylphenyl urea	14 days	12 hours	4
Ripcord 400 EC	cypermethrin	pyrethroid	7 days		2-3
Scala SC	pyrimethanil	anilinopyrimidine	14 days (<i>Botrytis</i>), 72 days (scab)	24 hours	5
Scholar 50 WP	fludioxonil	phenyl pyroles			1
Sevin XLR	carbaryl	carbamate	11 days		
Sniper	azinphosmethyl	organophosphate	14-21 days	14 days	4
Sovran	kresoxim-methyl	strobilurin	30 days	48 hours	4
Streptomycin 17	streptomycin sulphate	antibiotic	50 days	7 days*	3
Success 480 SC	spinosad	naturalyte	7 days	12 hours	3
Superior 70 Oil	mineral oil				1 (full rate)
Supra Captan 80 WDG	captan	phthalimide	7 days	48 hours	
Surround WP	kaolin		0 days		
Thiodan 50 WP	endosulfan	chlorinated cyclodiene	15 days		2 applications after calyx
Thionex 50 W	endosulfan	chlorinated cyclodiene	15 days		3
Vanguard 75 WG	cyprodinil	anilinopyrimidine	72 days	72 hours	2
Vydate L	oxamyl	carbamate	non-bearing only	48 hours	
Zolone Flo	phosalone	organophosphate	30 days	24 hours	3

* See label for specifics. May be more or less for some tasks.

Notes on Apple Insects and Diseases

Monitoring, thresholds and spray timings for mites on apples

Sampling protocol: From pink through petal fall, collect two spurs from each of 25 well spaced trees per block. Pick leaves at arm's length into the tree canopy. Include both ERM and TSSM in the count and record numbers of eggs nymphs and adults. After petal fall, switch to sampling two leaves from each of 25 trees.

TABLE 4-8. Thresholds for European Red Mite and Two-spotted Spider Mite on Apples

Stage of growth	Spray threshold and timing
Dormant to tight cluster	Superior oil: eggs present
Petal fall to 21 days after calyx	Apollo: first egg hatch and before more than 3 nymphs per leaf Agri-Mek: 5-7 active mites per leaf timed for 50% egg hatch
June to mid-July	Carzol, Kelthane, Kanemite, Pyramite/Nexter: 7-10 active mites per leaf Envidor and Acramite: > 5 active mites per leaf Apply when approx. 50% of population are nymphs
Mid-July to August	Carzol, Kelthane, Kanemite, Pyramite/Nexter: 10-15 active mites per leaf Envidor and Acramite: > 5 active mites per leaf Apply when approx. 50% of population are nymphs

TABLE 4-9. Activity of Miticides Registered on Apple and/or Pear in Ontario*

Product	Target Species	Lifestage(s) affected	Preferred timing	Comments on Knock-down
Superior 70 Oil	European red mite	Overwintering eggs, some nymphs	Half-inch green to tight cluster prior to hatch	Smothers eggs
Acramite 50 WS	European red mite (apple) Two-spotted spider mite (apple)	Nymphs, adults	Use at lower end of threshold	Rapid
Agri-Mek 1.9% EC	European red mite Two-spotted spider mite Pear rust mite (pear)	Nymphs	Within 21 days of petal fall	Rapid
Apollo SC	European red mite Two-spotted spider mite	Primarily eggs, newly hatched nymphs	Egg stage, before >3 active mites per leaf, no later than 14 days after petal fall	Slow activity
Carzol SP	European red mite Two-spotted spider mite	Nymphs, adults	Summer miticide	Rapid
Envidor 240 SC	European red mite Two-spotted spider mite Apple rust mite (apple) Pear rust mite (pear)	Eggs, nymphs, adult females	Post-bloom only, use at lower end of threshold	Slow activity (IGR-type)
Kanemite 15 SC	European red mite Two-spotted spider mite	All life stages	post bloom	Rapid
Kelthane 50 W	Two-spotted spider mite Apple rust mite (apple) Pear rust mite (pear)	Nymphs	Summer miticide	Rapid
Pyramite/Nexter	European red mite (ERM) Apple rust mite (ARM) Two-spotted spider mite (TSSM) Pear rust mite (PRM) (pear)	Nymphs and adults of ERM, ARM and PRM Nymphs of TSSM No effect on eggs	Summer miticide	Rapid

* Registered for use on apple or pear unless indicated otherwise. Use established thresholds to time applications. Miticides are most effective when applied alone, using recommended rates and water volumes. Apply each miticide only once per season to delay the development of resistance.

Monitoring and thresholds for tentiform leafminer on apples

Sampling protocol: Sample five spurs from each of five trees from the lowest limbs on each tree. After first egg hatch (or petal fall), collect five leaves from each of 10 trees from the lowest limbs. Sampling should be discontinued when tissue feeding mines become predominant since insecticides will not control this stage.

TABLE 4-10. Thresholds for Tentiform Leafminer on Apples

Stage of growth	Generation	Threshold
Prebloom or Calyx	1	3 eggs per spur (prior to egg hatch) OR 1 mine per leaf* (after egg hatch)
Summer	2	2 mines per leaf* (stressed trees) 4 mines per leaf* (healthy trees)
Summer	3	Generally control measures are not recommended for this generation

* Spray before tissue-feeders appear.

Management of apple scab with fungicides

Fungicides are used to control scab in most commercial orchards.

Here are some definitions of fungicide activity:

- Protectant activity is the ability of fungicide residues to inactivate and kill fungal spores and prevent infection.
- Pre-symptomatic or after infection activity is when fungicide prevents scab lesion development once the infection has occurred.
- Post-symptomatic or curative activity is the fungicide's ability to prevent or greatly inhibit the further production of secondary spores (conidia) when applied to sporulating scab lesions. Generally, applications of fungicides with this activity must be repeated for best effect.

Early season management

Management programs for primary apple scab infection are based on the timing and type of fungicide used. There are two general approaches: apply fungicides on a protectant program before infection

occurs or apply fungicides after infection but before symptoms develop.

Protectant fungicides

Fungicides are applied to expanding foliage before infection periods occur. Apply fungicides when conditions for infection are imminent.

- Begin the protectant fungicide program between silver tip and green tip. From first cover until early August, apply fungicides at 10–14 day intervals depending on rainfall frequency. New growth and expanding fruit must be protected and residues washed off by rain must be replaced. The exception to this is when using DMI fungicides (Nova and Nustar). Use a seven-day spray schedule regardless of rainfall.
- Some fungicides are not readily washed off and the residues are redistributed by rainwater.

Pre-symptomatic (after-infection) sprays

An after-infection spray is one applied within a specific time after the start of an infection period. The time available to apply the fungicide effectively depends on the product used and the average temperature. When you calculate after-infection activity, count the time interval from the beginning of the infection period. For example, at 6°C, apply Captan within 48 hours from the beginning of the infection period.

It is extremely risky to rely on pre-symptomatic or after-infection fungicide programs to control scab. To use this type of spray program successfully, equipment that can provide complete spray coverage under adverse conditions is necessary. Reliable and accurate temperature and leaf wetness monitoring equipment for each orchard is essential. Pre-symptomatic sprays should only be applied in orchards with a low level of primary inoculum.

Use of demethylation inhibitor (DMI) fungicides (sterol-inhibitors)

Nova 40 W and Nustar are members of demethylation inhibitors (DMIs), a group of fungicides loosely known as sterol inhibitors. These products must be used differently than protectant fungicides such as Captan or Mancozeb.

The main strength of the DMI group of fungicides is their relatively long post-infection, pre-symptom activity. These products can prevent new scab infection from establishing if applied within 72–96 hours after

infection. However, the DMI fungicides generally have only 3–5 days of protectant ability.

DMI fungicides must be absorbed by the leaf and fruit tissue to be effective. They are absorbed within one hour of application and their efficiency is not reduced if rain occurs more than one hour after application.

DMI fungicides are locally systemic, meaning they will move throughout leaves that are sprayed; however, they do not redistribute well to unsprayed tissues after application. Therefore uniform spray coverage is essential for good disease control.

Do not use Nova 40 W or Nustar earlier than tight cluster. Apply in combination with a protectant fungicide in blocks of two applications, 7–10 days apart. DMI fungicides are weak on fruit scab so do not start a DMI program after bloom. Apply Nova 40 W, or Nustar plus a protectant fungicide (e.g. Captan), no more than 72–96 hours after the beginning of a scab infection period. Do not stretch the interval between consecutive applications past 10 days. Apply at least two but no more than four sprays per season, preferably between tight cluster and first summer spray.

After a DMI plus a protectant fungicide application, leaves and fruit are only protected for five days. If not using a second DMI, apply a protectant fungicide before the next scab infection period. Follow up with a protectant fungicide program as required for the rest of the season.

Resistance to DMI fungicides can develop so it is imperative that resistance management strategies be followed. See *Fungicide resistance*, on page 71.

Use of strobilurin fungicides

Sovran and Flint 50 WG are members of a family of fungicides called QoI's or strobilurins. These products have good protectant and post-infection activity on apple scab and powdery mildew. Do not use Sovran or Flint 50 WG earlier than tight cluster and apply in blocks of two applications, 10 days apart. Due to the mode of action, it is important to follow resistance management strategies carefully. Use another chemical family for two applications before you return to either Sovran or Flint 50 WG. After an application of Sovran or Flint 50 WG, tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications.

Some strobilurin fungicides are phytotoxic to other fruit crops, such as Sovran for sweet cherries and Flint for concord grapes. Always check the label for precautions.

Use of anilinopyrimidine (AP) fungicides

Vanguard and Scala are members of the anilinopyrimidine family. These products have good protectant activity on apple scab. Vanguard and Scala do not control other foliar or fruit diseases (powdery mildew, cedar apple rust). For management of apple scab, make no more than two applications per season, pre-bloom only. Scala is registered as a pre-harvest spray to control post harvest diseases.

Control of apple scab under adverse weather conditions

Several consecutive days of continuous wet conditions and mild temperatures are common in the spring. These conditions encourage apple scab infection. It is often difficult to maintain sufficient fungicide on the trees to provide protection for the rapidly expanding foliage and fruit under such conditions.

If there is concern about adequate protection, it is better to apply a protectant-type fungicide during a break in the rain than to not spray at all. Be sure to use a fungicide with good retention properties. For example, products with mancozeb such as Dithane, Manzate and Penncozeb have good retention activity.

After-infection sprays may be required when protectant fungicides become too diluted to prevent the apple scab fungus from establishing itself on the foliage or fruit.

If an infection exists, scab lesions become visible on the foliage and fruit in about nine days at 20°C or in about 14–21 days if the average temperatures are 12°C or lower. Once this occurs you should avoid using fungicides with high potential for resistance (DMI's, strobilurins) and focus on protecting uninfected tissue from further infections.

Strong winds can hamper spray operations by causing pesticides to drift away from the intended target. Spray at night or early morning to help reduce spray drift. You can also lower the spray trajectory into the wind to minimize drift, but take extra care to ensure the treetops get good spray coverage.

Secondary scab management

The end of primary season can be determined through use of the degree-day model. At 418 DDC, over 95% of the ascospores are mature, and after a significant rain all of the ascospores have been discharged for the season. After this point, wait two weeks then check the trees for scab. It can take up to 14 days for lesions to appear after a scab infection period. Be sure to check the top of standard trees or anywhere else spray coverage may not have been adequate, for example a thick tree canopy.

If primary scab was controlled, the rates of fungicides may be reduced and the interval between sprays may be lengthened for the remainder of the growing season. Some growers have successfully eliminated all use of fungicides during the summer months where primary scab was controlled. If scab lesions are found, maintain a fungicide program for the remainder of the season.

Fungicide resistance

Several of the fungicide families available to apple growers are prone to the development of resistance. Therefore, it is critical to do as much as possible to minimize resistance risk. Implement these strategies to avoid or manage the development of fungicide-resistant scab populations in apple orchards:

- Always rotate between chemistries in a fungicide program.
- Never apply more than four applications of sterol inhibitors, strobilurins or anilinopyrimidines per season. For a list of fungicides by family group, see Table 2-8. *Fungicide/Bactericide Groupings Based on Sites of Action*, on page 16.

- Always use full rates of DMI fungicides with a half rate of protectant fungicide.
- Don't miss fungicide sprays at green tip.
- Be prepared to spray, in the rain if necessary, with Supra Captan, Maestro, Dikar, Manzate, Dithane, Penncozeb, or Polyram, but keep in mind you will lose the residual. Don't spray Nova, Sovran, Flint, Scala or Vanguard in the rain.
- Always apply fungicides preventatively before infection, not curatively after infection. The curative application of fungicides may encourage selection of fungicide-resistant populations.
- Always use full label rates of fungicides. Reduced rates of fungicides may increase the number of resistant individuals present in an orchard.
- Don't spray alternate rows.
- Don't extend spray intervals beyond those listed on the label. Shorten spray intervals in case of rain.
- Urea sprays may be applied to leaves on the orchard floor in November and/or the spring to increase leaf decomposition and reduce the apple scab inoculum the next spring. Flail mowing has also been shown to reduce inoculum levels.

For more information see, *Pest Resistance to Insecticides, Fungicides, Miticides*, on page 13 and *Resistance management strategies*, on page 13.

Do not apply DMI (sterol-inhibiting) or QoI (strobilurin) fungicides when scab lesions are present because this encourages resistance to develop.

TABLE 4-11. Activity of Fungicides on Apple Diseases

Ratings in shaded cells indicate the disease is listed on the product label for control or suppression. Use fungicides only for diseases listed on the product label for the crop and for the disease. Additional information is provided in this table to assist the grower in choosing the best fungicide for control of diseases listed on the product label.

Group	Fungicides	Apple scab	Powdery mildew	Cedar apple rust/quince rust	Black rot	Bitter rot	Sooty blotch	Fly speck
M1	Copper 53 W	+	+	+	+	+	+P	+P
M1	Kumulus DF	+	++	+	0	0	0	+
M1	Microscopic sulphur	+	++	+	0	0	0	+
M2	Dikar	+++	+++	++	+	NA	+++	+++
M2	Dithane DG	+++	0	++	0	NA	+++	+++
M2	Manzate Pro-Stick	+++	0	++	0	NA	+++	+++
M2	Penncozeb 75 DF	+++	0	++	0	NA	+++	+++
M2	Polyram DF	+++	0	++	0	NA	+++	+++
M3	Supra Captan 80 WDG	+++	0	0	+++	++	+	+
M3	Maestro 80 DF	+++	0	0	+++	++	+	+
M6	Equal	+++R	0	0	0	NA	0	0
3	Nustar	+++R	++	+++	0	0	0	0
3	Nova 40 W	++R	+++	+++	+	0	0	0
9	Vanguard 75 WG	++	+	0	0	NA	0	0
9	Scala	++	0	NA	NA	NA	NA	NA
11	Sovran	+++	++	+	+++	++	+++	+++
11	Flint 50 WG	+++	++	+	+++	++	+++	+++

P = Phytotoxic, causes russetting.

R = Resistance has been reported in some Ontario orchards. If you are uncertain whether there is a problem with resistance in your orchard, have it tested.

0 = No control.

NA = Not applicable because the fungicide is not applied at the timing for this pest.

+

Source: McSmith Agricultural Research Services.

Thinning and Growth Regulators

Chemical thinning of apples

Thinning of apples is required:

- to improve average fruit size and finish
- to create more uniformity in the crop
- to encourage return bloom and annual bearing

The objective of thinning is to reduce clusters to single fruitlets on most cultivars, preferably the king bloom fruitlet, and to adequately space fruit to every other bearing spur. An additional benefit from thinning clusters of set fruitlets to singles or doubles is reduced probability of pest damage. Some pests are more likely to damage clustered fruit.

The earlier thinning is accomplished after bloom, the greater the potential for an increased average fruit size and maximized return bloom the next year.

Thinning needs are based on grower experience. The previous thinning history should be well documented. Other factors include:

- the cultivars involved
- fruit sizes required
- strength of bloom
- bee activity
- weather conditions during pollination and following fruit set

Compared to a tree with an excessive crop load, a well-thinned crop has better colour and is more efficient to harvest, which translates into lower labour costs per bin at harvest.

Fruit size distribution in the tree canopy

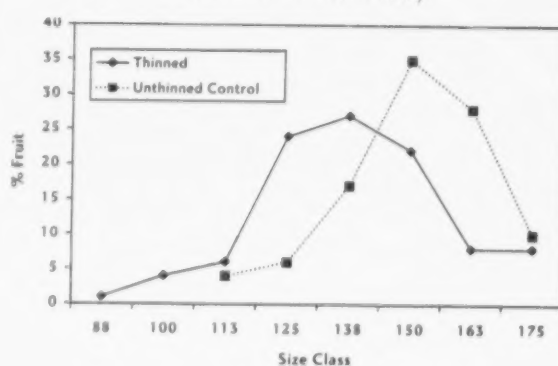
When you compare a well-thinned apple tree of any cultivar, to a tree that is insufficiently thinned, several factors become obvious.

- Size distribution of fruit within the canopy of both trees follows a normal distribution pattern. See Figure 4-2. *Fruit Size Distribution in the Canopy of a Thinned Empire Tree Compared to an Unthinned Control*, on this page.
- Other factors being equal, the average fruit size from the thinned tree is greater than that of an unthinned tree.

- While adequate thinning typically reduces yield, the value of the thinned crop more than compensates for any loss in yield provided the tree is not overthinned. In other words, where the fruit volume of thinned and unthinned trees is similar, the thinned tree has fewer apples but they are of greater size and higher value. See Table 4-12. *Tray Pack Size of Apples in Relation to Number of Apples per Bin and per Tree*, on page 74 for a comparison of fruit numbers of different size classes required to fill a standard apple bin.

FIGURE 4-2. Fruit Size Distribution in the Canopy of a Thinned Empire Tree Compared to an Unthinned Control

(Total yield differences by weight between the two trees was within 10%).



Chemicals available for thinning

Accel

Accel is an altered form of Promalin that contains the growth regulator benzyladenine (BA), which is the active ingredient for thinning, and gibberellin A₁A₂. Accel is registered for use in Canada at the rate of 2.5–4.0 L/ha, which is equivalent to 49–74 g BA/ha. The use of Accel is limited to two sprays per season, each containing no more than 74 g BA/ha. Since the label is based on product per ha, the maximum concentration applied depends on tree size and volume of water used to obtain good coverage. Research indicates that the concentration of BA in the spray solution is also important. Concentrations below 50 ppm BA are generally ineffective for thinning or improving fruit size.

Accel is not a satisfactory thinning compound for all cultivars but has exhibited effectiveness for Empire, McIntosh, Idared, Gala and others. See Table 4-15. *Suggested Rates for Chemical Thinning of Mature Apple Trees*, on page 81.

TABLE 4-12. Tray Pack Size of Apples in Relation to Number of Apples per Bin and per Tree

Minimum size				Number of apples required to fill bin ²	Number of apples required per tree for given tree density, desired yield and fruit size						
					Tree density (trees per acre) ³						
					272		500		1,000		
					Projected yield (Bu/ac)						
Tray Size	wt (g) ¹	in	mm		400	600	500	750	750	1250	
196	102	2 1/4	57	3,920	320	480	218	327	163	272	Juice
175	114	2 3/8	60	3,500	286	429	194	292	146	243	
163	123	2 1/2	64	3,260	266	400	181	272	136	226	
150	133	2 3/5	67	3,000	245	368	167	250	125	208	
138	145	2 3/4	70	2,760	225	338	153	230	115	192	
125	160	2 1/2	73	2,500	204	306	139	208	104	174	Target
113	177	3	76	2,260	185	277	126	188	94	157	
100	200	3 1/8	79	2,000	163	245	111	167	83	139	
88	227	3 1/4	83	1,760	144	216	98	147	73	122	
80	250	3 3/8	85	1,600	131	196	89	133	67	111	
72	278	3 1/2	89	1,440	118	176	80	120	60	100	
64	313	3 3/8	92	1,280	105	157	71	107	53	89	
56	357	3 3/4	95	1,120	92	137	62	93	47	78	
48	417	3 7/8	98	960	78	118	53	80	40	67	

¹ These values are approximate as fruit of the same diameter can differ in weight.² 18 bushel bin capacity.³ Trees spaced at approximately 3 m × 4.8 m (672 trees per ha; free standing central leader), 2 m × 4 m (1235 trees per ha; spindle type system) and 1 m × 3.7 m (2,470 trees per ha; super spindle).

Trees spaced at approximately 10 ft. × 16 ft. (272 trees per acre; free standing central leader), 6.5 ft. × 13 ft. (500 trees per acre; spindle type system) and 3.5 ft. × 12 ft. (1,000 trees per acre; super spindle).

Unlike other chemical thinners currently available in Canada, such as NAA and carbaryl, Accel has the potential to improve fruit size independent of thinning. Accel causes increased cell division shortly after flowering in the early stages of fruit growth and development and this translates into larger fruit at harvest.

The window of best response for Accel is between 5–12 mm fruitlet size.

Dilute Accel in 500–1,000 L of spray solution per ha. Uniform and thorough coverage is essential.

Environmental conditions

To optimize plant uptake of the spray solution, apply Accel when drying conditions are slow, for example, early morning. Best results are obtained when warm temperatures greater than 20°C occur during and after application. Always read the label before use.

Spray concentration

First, determine the concentration of BA to use. Second, determine the water volume required to wet the foliage just to the point of runoff. Then use

Table 4-13. *Accel Rate*, on page 75, to determine the volume of Accel to add to deliver the correct amount of BA in the appropriate concentration to be effective.

NAD (naphthaleneacetamide)

NAD, such as AMID THIN, is a hormone-type material that is absorbed by foliage where it induces formation of the abscission layer between the spur and the fruitlet. NAD is a relatively safe material. Apply NAD at first petal fall when petals on the king blossom are falling. Use concentrations of 50–100 ppm, depending on variety and growing conditions. NAD is particularly effective on hard-to-thin varieties such as Golden Delicious, if used at the proper time. NAD is mostly absorbed from the original solution. Once dry, the effect it has on thinning is over. Therefore use large water volumes applied under slow drying conditions. Weather that promotes soft, succulent and rapid growth leads to increased absorption. Avoid windy, cool, fast drying conditions. Temperatures between 21–24°C are considered optimum.

TABLE 4-13. Accel Rate

The relationship between spray water volumes required to thoroughly wet trees, g active ingredient (BA) per ha, and concentration of BA and per ha rate of Accel.

Spray volume required to thoroughly wet trees (L/ha)	Grams of BA per hectare				
	25	37	49	62	74
	Litres of Accel per hectare				
	1.3	2.0	2.6	3.3	3.9
	Concentration of BA in parts per million (ppm)				
200	124	185	247	309	371
300	82	124	165	206	247
400	62	93	124	154	185
500	49	74	99	124	148
600	41	62	82	103	124
700	35	53	71	88	106
800	31	46	62	77	93
900	27	41	55	69	82
1,000	25	37	49	62	74

Concentrations of BA in shaded area not recommended.

NAA (*naphthaleneacetic acid*)

NAA, such as Fruitone-N, is a hormone-type thinner that is absorbed primarily through the leaves. NAA affects auxin activity, and interferes with photosynthesis and proper fruit development. The fruitlet that is thinned usually drops within 10–14 days after a spray. Plants absorb NAA only when it is dissolved in water. Almost all NAA is absorbed from the original solution. Once dry, the thinning effect is stopped. Therefore use larger volumes of water under slow drying conditions. The longer the time required to dry the spray and the higher the drying temperatures, the greater the absorption of the NAA. NAA has a short life due to breakdown by sunlight. The most effective time to spray is under warm, dull, slow drying conditions. The preferred time is in the morning when the trees are damp; drying is slow and the temperature is on the rise. Once the material is absorbed, the tree has the day to respond to the thinner. NAA is considered to be rain fast after 2–3 hours. NAA is not effective at temperatures less than 10°C. NAA can result in leaf flagging (wilting) but these leaves recover in a few days.

Precautions

Do not apply Accel in combination with the hormone thinners NAA (*naphthaleneacetic acid*) or NAD (*naphthaleneacetamide*) either as a tank-mix or separate sprays during the same growing season. Doing so may result in pygmy fruit.

Carbaryl (*Sevin*)

Carbaryl is the active ingredient in the insecticide Sevin XLR. Carbaryl is absorbed primarily through the fruit, not the foliage. The presence of carbaryl in the vascular system of the fruitlet interferes with biochemical processes. Certain important fruit growth processes cease and the fruitlet drops. This fruitlet drop usually starts 5–10 days after application. Thinning with Sevin increases as concentrations rise up to 1.0 kg of active carbaryl (2.0 L of Sevin XLR) per 1,000 L of water. There may be little or no increase in thinning with higher concentrations. Carbaryl is relatively insoluble in water and low concentrations produce a saturated solution. This insolubility limits its effectiveness because absorption by the fruitlet is restricted to materials in true solution. This is an advantage however, because the hazard of over-thinning through concentration errors is reduced. Surface residues of the XLR formulation of Sevin, unlike the 50 W formulation, do not provide additional thinning effects when rain or dew cause re-wetting of the tree canopy. Although

Sevin is the easiest and safest thinner to use, it can be harsh on beneficial insects and mite predators.

1 L of Sevin XLR contains approximately the same amount of active ingredient (carbaryl) as 1 kg of Sevin 50 W.

Carbaryl (Sevin) plus NAA

This combination has been used successfully on hard-to-thin cultivars such as Paulared, Golden Delicious, Fuji and Gala strains. Use a constant rate of 1 L Sevin XLR (product) per 1,000 L of water with varying rates of NAA from 3–15 ppm. Since NAA only has one chance to work, use high water volumes.

Bee Warning

When Sevin is used in fruit thinning, extensive bee kills can occur if weeds or legumes are blooming in the ground cover. To minimize bee kills, remove bees from the orchard prior to treatment. Do not spray when the wind will carry Sevin to adjacent weedy or crop areas in bloom. Sevin XLR is much safer to use than Sevin 50 W around honeybees. Advise local beekeepers of your spray activity.

Factors influencing response to thinning agents

Length of wetting period and temperature for material absorption

Plants absorb thinning materials more quickly at higher temperatures than lower ones. Best temperatures for absorption are in the 20–25°C range. At these temperatures, drying time is usually much faster than early morning or evening when temperatures are 10–15°C cooler. Absorption under cooler conditions appears to be slower and stretches over a longer period or until the canopy dries.

The total amount of thinning chemical absorbed by the tree canopy appears to be more or less equal regardless of drying time, such as warm and fast or cool and slower. Time of day for application of thinners is not a critical factor. Research on selected cultivars suggests minimal differences in success based on timing of sprays during day or night. However, if you spray in early morning or evening, it will reduce

the likelihood of blowing thinners off target since winds tend to be more of a factor in the day.

Cultivar sensitivity (mature trees)

Easy-to-thin or easy-to-overthin cultivars include non-spur Red Delicious, Idared, Crispin (Mutsu), Jonagold strains, Jersey mac, Honeycrisp, Gingergold, Silken, Creston, Cameo and Golden Supreme.

Moderately difficult cultivars include Empire, McIntosh, Northern Spy, Cortland and Ambrosia.

Harder-to-thin cultivars include Golden Delicious, Paulared, Gala strains, Fuji, Goldrush, Spartan, Wealthy, spur-type McIntosh and spur-type Red Delicious.

Weather conditions

The following weather conditions may increase the thinning response because they permit greater absorption of chemicals:

- cool, wet weather and low light conditions before or after application
- prolonged period of high humidity without rain either before or after application
- high temperatures after cool periods
- frost or near-freezing temperatures before or shortly after application
- a prolonged period of dry weather before or after application
- excessively warm conditions following fruit set

A decrease in thinning response can result from sunny and warm daytime temperatures accompanied by relatively cool nighttime temperatures before and after thinning treatments have been applied. This results in a high net accumulation of carbohydrate reserves in the tree.

Pollination and bee activity

Pollination and bee activities are closely tied with weather conditions. Pollination conditions and bee populations may render fruit either more or less difficult to thin. Fruit set under good pollination conditions, which results in increased seed count, is harder to thin. Fruit set on king blossoms is more difficult to thin than fruit set on side blossoms. Single fruit are more difficult to thin than clustered

fruit. A light or spotty set with clustered fruit should be thinned, in order to break up the clusters.

Tree age and vigour

- Young trees are more easily thinned than mature trees that have cropped well for 2–3 years. Hand thin young trees of high-value cultivars that do not have a settled cropping pattern. Low rates of thinners that work on mature trees can easily over-thin young trees.
- Mature trees with winter-injured buds or trees that are low in vigour, for whatever reason, are more easily thinned.
- Trees bearing a heavy crop one year with good bloom the next year may be more easily thinned.
- The heavier the bloom, the more stress on the tree and the easier to thin. Because pollen has a high requirement for nitrogen, a heavy bloom will use additional nitrogen, and add stress to the tree.
- Stress from the previous season, for example excessively dry or excessively wet conditions, nutritional deficiencies and insects or disease, makes a tree easier to thin.

Density of foliage

- Poorly pruned dense trees are thinned more easily than well-pruned open trees with stronger fruit buds.
- Lower, partially shaded branches of well-pruned trees are thinned more easily than upper branches because of weaker spurs.
- If the thinning spray is delayed significantly, increase water volumes to ensure adequate coverage of the rapidly developing tree canopy and leaf surface area during the fruit set period.

Spray Coverage

As with all growth regulating sprays, coverage from the bottom to the top of the tree is essential for achieving good results. The thinning spray will act only where it is delivered. To check coverage, use Surround Crop Protectant as a marker.

Timing of application

- Application timings vary with the chemical used.
- Apply NAD during early petal fall. See *NAD (naphthaleneacetamide)*, on page 74.
- The best timing for applying NAA, Sevin and NAA + Sevin combinations is usually 7–12 days after petal fall¹. Early cultivars are an exception. Use seven days if it is warm and 12 days if it is cool.
- Sevin can be effective as a thinner when applied up to 21 days after petal fall.
- NAA is only effective if applied up to 12 days after petal fall. NAA applied too soon, in the bloom to petal fall period, can result in excessive thinning of Empire.

For some cultivars, apply chemical thinners based on the average fruitlet diameter. See Table 4-14. *Suggested Timing of Thinning (NAA)*, on this page. Thinners applied when the largest fruitlets, preferably the king bloom fruitlet, have reached the stated diameter, should cause the smaller and weaker fruitlets to drop off. This relationship works best when the king bloom fruitlet is larger than the side bloom fruitlets and when the size and stage of development of all fruit to be thinned is fairly uniform.

TABLE 4-14. Suggested Timing of Thinning (NAA)

Cultivar	Diameter of largest fruitlets in cluster
McIntosh	8.0–9.5 mm
Red Delicious	6.5–8.0 mm
Northern Spy	10.0–11.0 mm
Empire, Idared, Jonagold	8.0–10.0 mm
Gala, Golden Delicious, Fuji	8.0–9.0 mm

Sampling method to determine timing

Collect 50–60 fruitlets of each cultivar to provide a good estimate of fruit development in a reasonably uniform orchard block. Select the two largest developing fruits from each of 25–30 randomly selected clusters. Measure the greatest diameter of each using Vernier calipers or a thinning template and determine the average for the sample.

¹ Petal fall – when 80% of the petals have fallen but before calyx lobes are closed.

Steps in thinning

1. Determine how much thinning is required through an evaluation of the orchard factors and an assessment of fruit load potential. Sepals or calyx leaves on unpollinated blooms tend to stay open or bend back. Successful pollination and fruit set results in sepal movement and closure.
2. Determine the material to use and the concentration or strength of the thinner required.
3. Determine the water volume required to effectively wet the trees. Dilute water volumes are recommended when you apply chemical thinners. The average tree on M.26 (3–3.5 m tall) at a density of 720 trees per ha may require more than 2 L of spray per tree to thoroughly wet the foliage at the time of the thinning. As the tree size becomes smaller and the number of trees per ha increases, the volume of canopy that must be sprayed may become less. The tree-row volume concept is an accepted way to calculate required water volumes. Calibrate the sprayer and water volumes on small groups of trees to determine just how much water is required to thoroughly wet individual trees.

For more information, see OMAFRA Factsheet, *Guide for Spraying Fruit Trees*, Order No. 00-035.

Special conditions

Thinning after a badly frosted bloom

Depending on the severity of the damage, growers may thin sections or areas of the orchard that appear to have escaped the worst of the frost damage. Differences in elevation and airflow in the orchard can lead to great variations in frost damage to tree foliage and potential fruit set. Trees in the same block but on lower ground can be exposed to air 2–3°C colder than trees on higher ground in the same frost event.

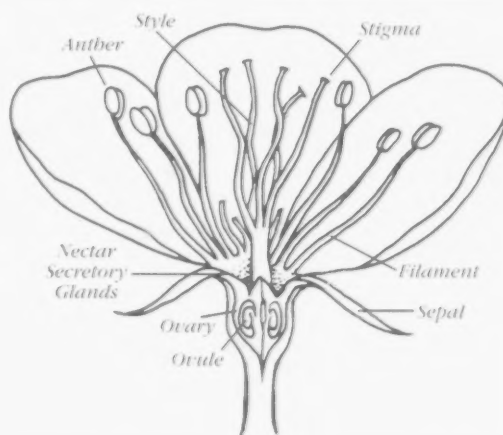
When deciding to apply thinners, the grower may plan to spray some of the block because of what appears to be a fairly normal set on trees on higher ground. Nozzles can be shut off in areas of the block that show significant potential losses in crop load from frost. Likewise, nozzles that direct thinning sprays into the lower canopy can be shut off if necessary.

Carefully evaluate damage to the bloom. Petals, stamens, pistils and ovaries can exhibit a significant difference in their response to freezing temperatures. See Figure 4-3. *Anatomy of an Apple Bloom*, on this page, for further details. Although flower petals are browned off by frost, the process of set can still take place from pollination that occurred 1–2 days before the frost event.

Frost around bloom usually produces a variety of frost damage symptoms. This includes bands of russetting that run either around the fruitlet, called frost rings, or lengthways from stem to calyx. Frost can also reduce seed count and result in a high proportion of misshapen fruit at harvest.

A light amount of frost damage should not prevent the use of thinning treatments that worked in the past for any given cultivar. However, exercise extreme caution when thinning after a significant frost. Leaves damaged by frost absorb more of the thinner and fruitlets with reduced seed count abscise more easily. Consider the application of lower rates of thinner for many varieties under these circumstances or, on a badly damaged block, do not apply a thinner but rely on hand thinning if necessary.

FIGURE 4-3. Anatomy of an Apple Bloom



Thinning when the king bloom is lost to frost

Response to thinning treatments is generally based on size and dominance differences within the cluster of set fruitlets. The king fruitlet of most cultivars is usually larger, stronger and more dominant than side bloom fruitlets, with the exception of Paulared. The king will normally hold on when weaker, smaller fruitlets drop in response to treatments.

If the king bloom or king fruitlet is lost to frost, size and strength differences among remaining fruitlets can be minimal, which makes them equally weak and vulnerable to thinners. The best approach in this case may be to wait until size differences appear in the cluster, provided the largest fruitlet is not greater than 12–14 mm. Size differences may become more apparent several days after full bloom. A few hours difference in pollination timing can show up in size differences of side bloom fruitlets as the post-bloom period progresses.

Thinning when weather conditions are poor

Weather conditions are often not suitable for the application of thinners even though the fruitlet diameter is at the recommended stage of development. Poor conditions can include cold, wet, windy or rainy weather that persists for days at a time. Growers are better off to wait for warmer temperatures, more sunlight and less wind, even though the fruitlet diameter could be larger than the diameter suggested for application of thinners. Thinners applied when king fruitlets are 12–14 mm in diameter will give a better response under warmer conditions than thinners applied to king fruitlets at 8–10 mm in persistent cold, wet and rainy conditions. Warmer temperatures include temperatures at or above 18°C during the day of application or for 24 hours after spraying.

Thinning an unevenly set crop

In most cases, apply thinners even when the crop is unevenly set. Single fruitlets are much tougher to remove from the canopy. These fruitlets can be present at the same time as multiple-set clusters in the same tree or block. In comparison, fruitlets found in clusters of 3–5 are easier to thin because of competition within the group. Ultimately, only 5–10% of the bloom in any cultivar is required to produce a commercial crop of fruit. Therefore, in situations of uneven set on unstressed trees and in the absence of frost injury, follow the recommended thinning treatments.

Cultivar notes

856923 (Aurora Golden Gala™)

856923 (Aurora Golden Gala™) can be extremely productive and therefore requires early and heavy thinning to create acceptable fruit size and quality. The cultivar appears to thin relatively well with

moderate rates of carbaryl. It requires a follow-up hand thinning to space fruitlets 15–20 cm apart. Crop load should be matched to trunk diameter. There has been a tendency to leave far too much fruit on the trees, resulting in small fruit size, delayed maturity, poor colour, poor taste and generally poor quality fruit. This cultivar responds well to the use of Surround Crop Protectant particle film during the growing season. This treatment helps to increase fruit size and improve shape and fruit finish.

Ambrosia

This spurry upright growing cultivar has been successfully thinned in Ontario with moderate rates of Sevin XLR. A well-thinned crop of Ambrosia finishes strongly with regard to size and colour development. The picking window for Ambrosia is narrow if the crop is to be held in long-term storage.

Cameo

Trees can normally handle heavy crop loads in a vigorous canopy. This cultivar has been shown to thin adequately with Sevin XLR (1 L/1,000 L water) on established trees.

Creston

Creston has been shown to overthin easily with low to moderate rates of Sevin XLR. It is a productive large size cultivar that requires two pickings.

Empire

Before the application of NAA, make sure the king bloom fruitlet is set through a check of sepal posture. Petal fall of king bloom can take place as early as 3–4 days past peak pollination. If NAA is used too early (full bloom to petal fall), the overall fruit size of unthinned apples may be reduced compared to treatment at a stage when the king fruitlet is 8–10 mm in diameter.

Enterprise

Enterprise appears to thin adequately with moderate rates of Sevin XLR.

Fortune

Fortune is a large sized, highly coloured, dual-purpose apple that requires thinning to avoid biennial bearing. Fortune requires a strong treatment of NAA in combination with Sevin XLR. Experienced

growers have reported success with 10 ppm NAA plus 1 L of Sevin XLR per 1,000 L of water.

Fuji

This cultivar exhibits strong biennial characteristics and unthinned Fuji normally returns very little bloom the next year. Fuji must be thinned aggressively for best results. Mature trees usually thin adequately with combinations of Sevin and NAA, but follow-up hand thinning is usually necessary to further reduce the number of king fruitlets. Excessive crop may prevent the fruit from maturing to premium quality.

Calculating Parts per Million (ppm)
1 ppm = 1 g active ingredient
per 1,000 L water

Gala

Gala is relatively difficult to thin successfully. On mature trees, the approach must be aggressive. Good results have been achieved using a combination of NAA and Sevin at the rates listed for Golden Delicious. The suggested timing for this application is when king fruitlets are at 8–9 mm. Fruit size potential is determined within two weeks following calyx. Clusters must be thinned to one fruitlet or king bloom by mid to late June. A follow-up hand thinning within 30 days of full bloom is normally required to further reduce crop load.

There appears to be a relationship between timing of thinning sprays and the production of mummified fruitlets colonized by the fungus which causes black rot. Earlier applications produce fewer mummies. This reduces black rot inoculum, and maturing fruit is less likely to be infected.

Gingergold

This cultivar appears to be more sensitive to thinners than McIntosh, Northern Spy and Empire. It can be overthinned with high rates of NAA or strong combinations of NAA and Sevin XLR or Accel plus Sevin XLR. Most growers would consider this cultivar to be uncomplicated as far as thinning requirements go.

Golden Supreme

Unlike Golden Delicious, this mid-season Golden Delicious type will thin adequately with 1 L of Sevin XLR per 1,000 L water.

Goldrush

Goldrush requires a combination of NAA and Sevin XLR (10 ppm NAA + 1L Sevin XLR per 1,000 L water). This cultivar is much tougher to thin adequately, but a well-thinned crop will mature more easily.

Honeycrisp

This cultivar seems to be more sensitive to thinning treatments than Empire. Thin Honeycrisp cautiously, as it can easily become oversized and is very prone to bitterpit. If the block produces fruit that are too large, it may be best to leave two fruitlets per cluster. Use of growth regulators, which enhance fruit size, may not be warranted for this large fruited cultivar. Use no more than 2.5 ppm NAA with 1 L of Sevin XLR per 1,000 L of water as a starting point on established trees. Many growers report good fruit size distribution when the largest fruitlets are removed by hand thinning following the spray thinning treatment. Honeycrisp is highly biennial in nature and may not return an adequate crop year after year.

For a discussion on crop load and trunk circumference with respect to thinning see OMAFRA Factsheet, *Commercial Production of Honeycrisp Apples in Ontario*, Order No. 05-047.

Jonagold

This cultivar thins relatively easily and has good size potential when clusters are thinned to singles. Most producers get adequate thinning with moderate rates of Sevin. Over-cropping Jonagold may result in very poor return bloom and fruit may not mature to a premium quality.

Shizuka

Shizuka thins similarly to Crispin with moderate rates of Sevin XLR.

Silken

Silken thins with 1–1.5 L of Sevin XLR per 1,000 L of water, depending on tree age. This cultivar bruises easily. Evenly spaced fruit in the canopy is desirable because it enables careful picking and handling.

TABLE 4-15. Suggested Rates for Chemical Thinning of Mature Apple Trees¹

Use ONE of the following:

Cultivar	NAD ppm ²	NAA ppm ²	Sevin XLR L/1,000 L	Sevin XLR +NAA ppm ² /1,000 L water	Accel (g BA/ha) ³	Sevin XLR (L/1,000 L water) ² + Accel (g BA/ha) ³
Lodi, Melba, Quinte, Yellow Transparent	50-75	—	—	1 L + 10-15 ppm	—	—
Early McIntosh	75-100	—	—	1 L + 5-10 ppm (at petal fall)	50-75	—
Jerseymac, VistaBella, Tydeman's Red	—	5-10	1-1.5	—	—	—
Paulared	50-75	12-15	1-1.5	1 L + 10-15 ppm	75	1 L + 50
Spartan, Russets	—	10-20	1-2	1 L + 10-15 ppm	—	—
Cortland	—	5-10	—	1-2 L + 2.5-5 ppm	—	—
Ambrosia	—	—	1-1.5	—	—	—
8S2963 (Aurora Golden Gala™)	—	—	1-1.5	—	—	—
Silken	—	—	1-1.5	—	—	—
Cameo	—	—	1	—	—	—
Creston	—	—	.5-1.0	—	—	—
Non-spur McIntosh	—	5-10	1-2	—	50	—
Spur-type McIntosh	—	10-12	—	1-2 L + 2.5-5 ppm	50-75	1 L + 50
Golden Delicious, Wealthy	75-100	10-20	1-2	1 L + 5-10 ppm	75	1-2 L + 50
Golden Supreme	—	—	1	—	—	—
Goldrush	—	—	—	1 L + 10 ppm	—	—
Red Delicious	—	2-8	0.5-1.5	—	—	—
Spur-type Red Delicious	—	5-10	—	1-2 L + 5-10 ppm	—	—
Idared	—	2-8	—	—	50	—
Empire	—	7-10	1-1.5	1 L + 2.5-4 ppm	50-75	1 L + 50
Spy. Crispin (Mutsu)	—	5-10	0.5-1.5	—	—	—
Jonagold	—	—	1-1.5	—	50-75	—
Fuji	—	—	—	1-1.5 L + 10-12 ppm	—	1-2 L + 50-75
Gala	—	10-12	—	1 L + 5-10 ppm	75	1-2 L + 50
Honeycrisp	—	5	1-1.5	1 L + 2.5 ppm	—	—
Gingergold	—	7-10	1-1.5	1 L + 2.5-5 ppm	—	1 L + 50

— Indicates treatment recommendation not available.

¹ The above rates are suggested for trees with a settled cropping history. To chemically thin a first crop tree or trees considered to be immature is very risky.² Sufficient water volumes must be used to thoroughly wet trees. See *Steps in Thinning*, on page 78.³ Consult Table 4-13. *Accel Rate*, on page 75, to determine the actual ppm benzyladenine (BA) being applied. Concentration of BA should be no less than 50 ppm to be effective. 1 L of Accel contains approx. 19 g of BA.

Note: The rates for Sevin are amounts of product. Sevin XLR is 43% active ingredient and contains 480 g or approximately 0.5 kg of carbaryl per L. 1 L of Sevin XLR is roughly equivalent to 1 kg of Sevin 50 W. For actual amounts of NAD and NAA refer to the label of the product being used.

Suggested rates for chemical thinning of apples

The rates in Table 4-15, *Suggested Rates for Chemical Thinning of Mature Apple Trees*, on page 81, are guidelines only. There is no substitute for personal experience. It is important to keep yearly records on weather conditions, rates, etc., and above all, leave some trees unsprayed to help assess the thinning response. Use only one of the suggested chemical treatments. For example, with Wealthy, apply NAD or NAA or Sevin, or the combination. Before you alter or modify a treatment that has proven to be effective, consult with a crop consultant.

Defruiting Immature Apple Trees

In some cases, it is desirable to defruit immature apple trees to encourage proper tree development. A dilute spray of NAA at 15 ppm combined with Sevin XLR at 1.5–2 L/1,000 L of water five days after petal fall, gives acceptable results. Well-established, supported trees under minimal stress can carry some crop load in the second year following planting.

Key concepts and benefits of hand thinning

For highly-valued cultivars, hand thinning immature trees is less risky than spray thinning. Hand thin promptly after June drop.

Hand thinning:

- helps to increase fruit size and helps to manage fruit development
- helps to single the fruitlets
- balances the number of fruiting spurs with resting spurs
- enhances return bloom
- improves pest control because spray coverage is more uniform on unclustered fruit
- improves efficiency in harvest and handling of crop
- allows the tree to continue to develop canopy
- helps to prevent runted trees

Growth Regulators

Promalin to improve fruit shape of Delicious

Promalin is a plant growth regulator used on Red Delicious apples. Promalin improves the typiness or shape of Red Delicious apples through elongation of the fruit and development of more prominent calyx lobes. It contains a mixture of benzyladenine and two types of gibberellins. For satisfactory results when you use Promalin, time the application carefully, pay attention to the label and ensure complete spray coverage.

Precautions

- If Promalin is applied at higher rates or volumes than those recommended on the label or where blooms are weak or frost-injured, fruit thinning may occur. Promalin use may also increase the amount of thinning achieved with subsequent blossom thinning sprays.
- Apples may not respond to Promalin if spur vigour is low or the king blossoms have been damaged by frost.
- Do not apply Promalin if rain is expected within six hours.
- Do not apply when air temperatures are lower than 24°C or greater than 32°C.

Application notes

- For optimum results, spray the first application of Promalin between full king bloom and early petal fall. Applications earlier or later are likely to produce unsatisfactory response.
- High relative humidity and slow drying conditions favour maximum absorption. It is preferable to apply in morning or evening.

Ethephon to promote fruit colouring

Ethephon (Ethrel) has the following effects on trees and fruit, depending upon the timing and rate of application:

- Ethrel stimulates ripening, colour development and fruit drop. To prevent excessive premature drop after the use of Ethrel, apply a suitable stop-drop product such as naphthaleneacetic acid (NAA). Two applications are required: one as a tank-mix at the time Ethrel is applied and the

second five days later. Apply the stop-drop at the normal rate recommended on the label.

- Spray just the number of trees that can be harvested over a 2–3 day period. Depending on cultivar and air temperature, fruit will be ready to harvest 5–10 days after the spray is applied. After a spray, check the maturity of the apples on a daily basis for pressure, starch, flavour and colour. A few trees sprayed at 3–4 day intervals are easier to manage than a large number sprayed at one time. Make sure a market is available for the treated apples before you spray, especially with early cultivars.
- Rates of application depend on cultivar, date of application, tree vigour, temperature, weather conditions and degree of response required. The response to Ethrel is a chemical reaction that depends on temperature. For this reason, early cultivars, such as Jersey Mac and Paulared, require less material than later cultivars. On early cultivars, use 0.75–1.5 L of Ethrel per ha with sufficient water to wet the trees thoroughly. McIntosh requires 1.5–4.25 L/ha. Use the higher rate early in the season on trees high in nitrogen or on poorly pruned trees. Lower rates may be better nearer normal harvest on young, well-pruned trees or on trees low in nitrogen.
- Best results are obtained when Ethrel is applied 2–3 weeks before harvesting. Be sure to apply Ethrel uniformly, since it works only where the spray touches.

Chemical control of preharvest drop of apples

Cultivars differ in their tendency toward preharvest drop. In this respect, McIntosh gives the greatest concern in Ontario.

Conditions associated with premature fruit drop include:

- trees with high nitrogen content in late summer
- trees that carry a heavy crop
- hot days and warm nights just before and during harvest
- trees deficient in either moisture or the nutrients boron or magnesium
- trees heavily infested with spotted tentiform leafminer

Products such as Fruitone-N and Fruit Fix Concentrate contain NAA (naphthaleneacetic acid)

and are registered to control drop on apples. These contain the same active ingredient, NAA, used earlier in the season for thinning the crop, at different concentrations.

- Apply NAA as soon as the first undamaged apples begin to drop, at the rate of 10 ppm or single strength rate. Timing is important. Do not confuse the normal preharvest drop of sound apples with those that have been pushed off or are dropping because of insects, disease or nutritional deficiency.
- NAA is effective for 7–10 days after it is sprayed. For stop-drop prevention beyond this, repeat the application of a single strength rate every 7 days. It takes 1–2 days for NAA to take effect if applied before any harvest has taken place. If applied after the orchard has been spot picked, it may take longer to take effect. Therefore, apply NAA as soon as the spot pick is finished. Do not apply NAA closer than five days before harvest. Refer to the label.
- Apply NAA in a dilute spray. A dilute application favours more uniform coverage. This is important because NAA is only locally systemic. High volumes of water take longer to dry and allow increased absorption of NAA. The optimum conditions for maximum absorption are at or near 21–24°C and high humidity. Absorption is less on foliage injured by insects, diseases or frost and at temperatures below 16°C.
- The addition of a non-ionic type spreader sticker like Agral 90, improves absorption of NAA under less than ideal weather conditions.
- NAA inhibits fruit abscission but the fruit continues to mature at an accelerated rate. The higher the concentration used and the greater the number of applications, the greater the ripening effect. One application of single strength (10 ppm) has little effect on direct ripening.
- Do not store apples, particularly McIntosh, in late-opening controlled atmosphere (CA) or long-term cold storages if they have been treated with NAA. Market apples immediately if trees were treated a second time with NAA.

Recommendations for use of ReTain

ReTain is a plant growth regulator and an effective preharvest drop control agent for apples, such as Honeycrisp, McIntosh, Red Delicious and Northern

Spy. It inhibits the production of ethylene in maturing apples.

- Apply this material four weeks before anticipated harvest date. ReTain may delay maturity of apples on the tree and allow a longer harvest window for a particular variety. Although ripening in ReTain-treated fruit is temporarily delayed, treatment with ReTain may increase soluble solids, colour, fruit size, fruit firmness and reduce the incidence of water core.
- Pick fruit treated with ReTain at the same internal maturity, based on starch-iodine tests, as untreated fruit. There may be a 7–10 day delay from predicted harvest date of untreated fruit to the start of the harvest of ReTain-treated fruit.

Recommended use 4–5 weeks before anticipated harvest

- Use one 333 g pouch (50 g active ingredient) of ReTain per 0.40 ha (1 ac.). Use with Sylgard 309 (organosilicone surfactant) at 0.5–1.0 L of Sylgard 309 per 1,000 L of water.
- Apply four weeks before anticipated harvest, adjusted for any seasonal differences that have advanced or delayed the “normal” harvest date for that year. If this date is uncertain, it is better to be a week early, than a week late. Late applications will not perform well because ethylene production within the plant may have already begun and this is difficult to suppress once initiated. To help determine the start of the “normal” harvest period, refer to historical trends for harvest dates for each cultivar in your area.

Precautions

- When you mix ReTain with the surfactant, keep agitation to a minimum because Sylgard 309 has a tendency to foam.
- To minimize foam, add Sylgard 309 last, when the tank is full. Compatibility and performance data for ReTain with antifoam products are not available.
- Do not use surfactants other than Sylgard 309 because they are not registered with ReTain in Canada. If the rate of ReTain is reduced, maintain the Sylgard rate at a 0.05%–0.1% v/v ratio.
- Discard any unused spray material at the end of each day.

- Do not tank-mix with other products except Dipel or Foray. Combination effects and potential interactions between ReTain and NAA (naphthaleneacetic acid) or Ethephon products have not been thoroughly evaluated. Use of these products on ReTain-treated blocks may negate or reduce the benefits of ReTain.
- Do not overhead irrigate for eight hours after applying.
- Adjust spray water volumes based on tree size and spacing. Do not apply to the point of runoff but wet the tree under slow drying conditions. Use tree-row volume (TRV) reductions cautiously and test on a few rows or small blocks to gain a level of comfort with this technique. For many orchards, 1,000 L water per ha is adequate for size-controlling rootstocks.
- For best results, have spray water at a pH between 6 and 8.

For best storage performance of ReTain, segregate treated fruit from untreated fruit to reduce exposure to ethylene.

Additional considerations when using ReTain

- Spray only trees that are healthy and not under severe drought, insect, disease or nutritional stress.
- Apply treatments to Gala strains, Golden Delicious types and Honeycrisp with caution. These cultivars appear to be more responsive to ReTain compared to McIntosh. Using ReTain on these sensitive cultivars can significantly impede crop maturity and development.
- For multiple-pick cultivars such as Royal Gala, time application four weeks from the second harvest pick date for best results.
- The harvest window for treated cultivars is shorter but delayed and results in fewer pickings. This can increase harvest efficiency.
- ReTain is not likely to compensate for the effects of an aggressive calcium spray program to control bitter pit. Calcium sprays can advance apple maturity by accelerating ethylene production in maturing fruit.

Preventing heat stress and fruit sunburn on apple and pear trees

Surround WP Crop Protectant is highly refined kaolin clay. Applied to the tree canopy, it forms a uniform microscopic particle film that protects both leaves and fruit from high UV light and heat. Because excessive heat and high UV can slow the photosynthetic rate in a tree canopy, untreated trees assimilate less carbon in the heat of the day.

The use of Surround WP on young apple and pear trees during their establishment can provide several benefits to growth and development. It can:

- increase net accumulation of carbon from photosynthesis
- enhance fruit bud initiation
- increase trunk diameter
- increase shoot growth

In established orchards, trees treated with Surround have shown better foliage health through to leaf drop. Plant dormancy is not affected. Improvements in fruit finish and marketable yield have been documented on several cultivars.

To prevent heat stress, make two applications of Surround WP, 7 days apart, using 50 kg/ha. Begin spraying before heat stress is likely to occur. Continue applications at 7–14 day intervals and use a reduced rate of 25 kg/ha to maintain even coverage.

Surround WP is made of an inert, non-reactive grade of kaolin that is not absorbed by plant tissues. The kaolin is food grade quality and approved by both the PMRA and EPA. Surround WP is OMRI listed, highly refined and suitable for reduced risk programs.

Precautions when using Surround

- Do not mix Surround with spreaders, stickers or anti-foaming agents.
- Do not spray when bees are active.

In orchards treated with Surround, monitor fruit maturity carefully and use starch iodine tests in the last two weeks of crop development.

For detailed application instructions, see the product label.

Vegetative growth control in apples

Apogee or prohexadione-calcium, is a plant growth regulator that reduces terminal shoot growth. Apogee inhibits the synthesis of gibberellins, the plant hormones responsible for cell elongation. Trees treated with Apogee often have the same number of shoots as untreated trees, but shoots from treated trees are thicker or greater in diameter and have compressed internodes.

When used properly in apple orchards, Apogee can:

- reduce shoot growth by 20–60% and diminish the time required to dormant prune and/or summer prune
- lead to improved fruit colour on red-coloured cultivars
- result in a more open tree canopy, which will improve spray coverage
- reduce the incidence and severity of fire blight on shoots, but not blossom blight infections

Apogee does not have activity against the fire blight bacteria. Trees with reduced shoot growth make the trees less susceptible to fire blight development.

Apogee does not reduce the number of leaves or fruit size.

Time of application and rates

Patterns of terminal growth and fruit set differ among growing regions. Likewise, the response to Apogee appears to differ depending upon where it is used. Therefore, the rate and calendar date of application may vary from region to region.

Make the first application when terminal shoots (and/or bourse shoots) are no longer than 2.5–5.0 cm. Some cultivars show early bourse shoot development (see Figure 4-4. *Diagram Indicating Bourse Shoot Development*, on page 86). This typically coincides with late bloom or petal fall, when sufficient leaf area has developed for Apogee to be translocated into the leaf. Later timings will not provide satisfactory results.

**FIGURE 4-4. Diagram Indicating
Bourse Shoot Development**

Apogee is non-toxic to bees, so the first application can be made before bees are removed from the orchard.

Once applied, Apogee requires about 14 days to slow growth. It breaks down in the trees within a few weeks, so at least one additional application may be necessary to maintain growth control throughout the entire growing season.

See Table 4-16. *Suggested Apogee Rates and Timings Based on a Tree-row Volume Dilute of 1,000 L/ha*, on this page for rates. The application rate is determined primarily by tree size, vigour, and whether protection against shoot blight is an objective.

- for medium to high vigour trees apply 45 g product per 100 L of dilute spray (125 ppm)
- for low to medium vigour trees apply 27 g product per 100 L of dilute spray (75 ppm)

Repeat application(s) should be made at 14–21 day intervals, based on the level of growth control required.

TABLE 4-16. Suggested Apogee Rates and Timings Based on a Tree-Row Volume Dilute of 1,000 L/ha (This chart is to be used in conjunction with the product label.)

Level		1st Spray	2nd Spray	3rd Spray	4th Spray	Season total ² (g/ha)
	Typical Date ³ →	25-May	8-Jun	22-Jun	6-Jul	
	Stage →	Petal Fall	Fruit set	June Drop	↓ growth	
	Tree vigor ¹	(g Apogee per ha based on 1,000 L/ha TRV (tree-row volume) Dilute) ⁴				
1	Low – 1 spray	450				450
2	Low – 2 sprays	270	270	—	—	540
3	Medium – 2 sprays†	450	450	—	—	900
4	Medium/High – 3 Sprays	450	450	270	—	1170
5	High – 3 sprays	450	450	450	—	1350
6	High – 4 sprays	450	450	450	270	1620

[†] - Suggested base rate. Move to next higher or lower level based on factors listed below.

Orchard and Environmental Factors to Adjust Apogee Rates and Number of Sprays

Heavy dormant pruning	increase rate by 10–20 % per ha per spray
Longer growing season	add 3rd or 4th spray
Low crop load	move Apogee Program to next higher level
Questionable coverage	move Apogee Program to next higher level
Fire blight suppression	move Apogee Program to next higher level or apply (650 g/1,000 L) initial rate

¹ Vigour is defined as the total amount of shoot growth in a single season. Not to be confused with tree-row volume.

² Maximum seasonal rate should not exceed a total of 5.4 kg of Apogee.

³ The first application will depend on growth development in your area and by cultivar. Apples trees in Niagara and southwestern Ontario are often 7–10 days ahead in development compared with trees in Georgian Bay and Eastern Ontario.

⁴ Tree-row volume (see OMAFRA Factsheet, *Guide for Spraying Fruit Trees*, Order No. 00-035 for more details). Rates need to be increased when higher water volumes are required for adequate spray coverage.

Follow the steps on the label to adjust rates for tree-row volume dilute applications. Table 4-16. *Suggested Apogee Rates and Timings Based on a Tree-row Volume Dilute of 1,000 L/ha*, on page 86, shows various rates for sprays applied at 1,000 L/ha (dilute). Apogee has been used effectively when applied in more concentrated sprays provided thorough wetting of the canopy is achieved. Low-volume spraying of plant growth regulators and chemical thinners is not recommended.

Do not tank mix Apogee with calcium sprays like calcium chloride. In the presence of calcium, Apogee will precipitate in the tank, clog nozzles and screens, and reduce tree response.

Adjuvants and hard water

- Include the spray adjuvant, Agral 90, with Apogee to improve the uptake of the prohexadione-calcium molecule by the leaf.
- In addition, if the spray water source is hard water and contains high levels of calcium or magnesium, include an equal amount of ammonium sulphate (AMS) fertilizer by weight with Apogee. Use a high-quality, greenhouse grade of AMS to avoid plugging of nozzles.

Obtain water hardness ratings from your municipal water supplier. Have well water tested for hardness.

Consult www.ene.gov.on.ca/en/water/sdwa/licensedlabs.php for a list of accredited labs.

Precautions when using Apogee

In some instances, Apogee may increase the strength of fruit set and make thinning more difficult. This response is not consistent but is more likely at concentrations above 125 ppm (45 g/100 L). Apogee-treated trees may require more aggressive chemical or hand thinning to reduce the crop load to the desired level.

Research in the United States suggests that Apogee can cause severe cracking on Empire and Stayman cultivars. The cause is unclear, and it has not been observed in research blocks in Ontario after treatment of Empire trees for several years. Producers who wish to use Apogee on Empire should be aware of this precaution and use it on limited acreage of their Empire trees for a few years to determine the real risk of cracking in our region.

Apogee may result in decreased yield and marketable yield of Cortland. Despite this, clear benefits of the use of Apogee on tip bearing cultivars such as Cortland and Northern Spy have been observed in other regions of Canada where the shortened internodes of Apogee treated trees has produced a more compact tree habit.

5. Berry Crops

Berry Crop Nutrition

Blueberries, Highbush

Blueberries perform best on acidic, well-drained soils with high organic matter content.

- Before you plant, test to determine the pH of the soil and fertilizer requirements.
- Incorporate acidic peat moss with the soil in the planting hole to significantly improve plant establishment and development. Dry peat moss will draw soil moisture away from plant roots so be sure it is thoroughly moistened before planting.
- For information on increasing soil organic matter, see *Soil Management* at ontario.ca/crops.

pH requirements

Blueberries require a soil pH between 4.2 and 5.0 for optimum growth and production. A soil pH above 6.5 usually cannot be lowered economically through the use of sulphur or peat moss. For this reason, choose the site for blueberry production carefully.

- If the soil pH is too high but less than 6.5, acidify through the incorporation of elemental sulphur and/or acidic peat moss prior to planting. See Table 5-1, *Amount of Sulphur Required to Lower Soil pH*, on this page. This also provides essential organic matter.
- Incorporate sulphur one year prior to planting to allow sufficient time for the sulphur to acidify the soil.
- Check the soil pH annually in the plant row and add sulphur when necessary.

Fertilizer for blueberries

Nitrogen (N)

Highbush blueberries respond best to ammonium forms of nitrogen. Use ammonium sulphate (21% N)

if the soil pH is above 5.0 and urea (46% N) if the pH is below 5.0. Avoid the use of the nitrate form of nitrogen. Avoid fertilizers containing lime filler as they will raise the pH of the soil.

- In the spring after planting, apply a total of 12 g of actual nitrogen per bush in a split application. Increase the rate of nitrogen each year until a total of 36–48 g per bush is applied. Apply the nitrogen just prior to bud break, petal fall and early July.
- Distribute the fertilizer in a circle from 30 cm around the plant to just beyond the spread of the branches. On older bushes, apply most of the fertilizer under the outer spread of the branches. See Table 5-2, *Nitrogen Requirements for Highbush Blueberries*, on this page.

TABLE 5-1. Amount of Sulphur Required to Lower Soil pH (kg/ha)

Soil type	For each 1.0 pH unit	For each 0.1 pH unit
sand	350	35
sandy loam	750	75
loam	1,100	110

Example: The initial pH of a sandy loam soil is 6.2; the desired soil pH for blueberries is 4.8. The soil pH must be lowered by $6.2 - 4.8 = 1.4$ units. Therefore, $1.4 \times 750 = 1,050$ kg/ha of sulphur is required.

TABLE 5-2. Nitrogen Requirements for Highbush Blueberries

Plant Age	April 1–15	May 15	July 1
	(g N per plant)		
Newly set	0	6	6
1 year	3	6	6
2 year	6	6–12	6–12
3 year	9	6–12	6–12
4 year	12	12–18	6–12
5 year	15	12–18	6–12
6 year or older	18	12–18	6–12

TABLE 5-3. Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries

Phosphorus				Potassium		
		Phosphate required kg P ₂ O ₅ per ha				Potash required kg K ₂ O per ha
Soil test (ppm P)	Rating	New plantings	Established plantings	Soil test (ppm K)	Rating	
0–3	HR	140	100	0–15	HR	130
4–5		130	90	16–30		120
6–7		120	80	31–45		110
8–9		110	70	46–60		100
10–12		100	70	61–80		90
13–15	MR	90	60	81–100	MR	80
16–20		70	50	101–120		70
21–25		60	40	121–150		60
26–30		50	30	151–180		40
31–40		40	20			
Above 40	LR	0	0	Above 180	LR	0

HR, MR, LR, denote, respectively, high, medium, AND low probabilities of profitable crop response to applied nutrient.

Phosphorus (P) and Potassium (K)

Apply phosphorus and potassium according to soil tests. Consult Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, on this page, for soil test interpretation. A single application of phosphorus at soil preparation time is usually all that is required. It is critical to correct phosphorus deficiencies prior to planting.

Apply all of the required potassium early in the spring under the outer branches of the bushes as described for nitrogen. Potassium can be mixed and applied with the spring nitrogen. Use sulphate of potash magnesia (22% potash, 11% magnesium) or potassium sulphate (50% potash). Blueberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60).

Other nutrient requirements

Magnesium (Mg) deficiency may occur on blueberries. Soil and/or foliar applications of magnesium are required to correct this deficiency. For soil applications, 80 kg Mg per ha is required where a confirmed deficiency exists. Use magnesium sulphate (Epsom salts, 9.5% Mg) or sulphate of potash magnesia (21% potash, 11% Mg). Since sulphate of potash magnesia contains potash, adjust the rate of application to coincide with potash requirements. For foliar sprays, 1.9 kg Mg per 1,000 L of water (20 kg magnesium sulphate, Epsom salts) with at least

2,000 L/ha should correct the deficiency. Annual foliar sprays may be necessary.

Leaf analysis

Leaf tissue analysis can help to assess the nutrient status of the plants and more accurately determine fertilizer requirements. In late July, take leaf samples from halfway down the new shoot growth of the current season. For adequate representation, collect at least 100 leaves throughout the sampling area. Sample areas with different soil, plant vigour, fertility programs, etc., separately. See Table 5-4. *Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves*, on this page.

TABLE 5-4. Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves

Element ()	Acceptable Range
Nitrogen (N)	1.7–2.3%
Phosphorus (P)	0.15–0.40%
Potassium (K)	0.36–0.7%
Calcium (Ca)	0.3–0.8%
Magnesium (Mg)	0.12–0.3%
Manganese (Mn)	150–500 ppm
Iron (Fe)	30–100 ppm
Zinc (Zn)	10–100 ppm
Boron (B)	15–50 ppm

See Appendix C, *Accredited Soil-Testing Laboratories in Ontario*, on page 211, for a list of laboratories that provide leaf analysis.

Currants and Gooseberries

It is essential to apply and incorporate required materials such as phosphorus, potassium, organic matter and lime before you plant currants and gooseberries because these materials do not move through the soil easily.

- Prepare the soil at least a year before planting so the plants can maintain productivity and grow successfully in the same location for many years.

Currants and gooseberries grow best in cool, well-drained, deep, loamy soils. The soil should have a rich supply of organic matter, at least 2–3%, to promote good drainage, aeration and moisture retention.

- Apply 45 tonnes/ha or 4.5 kg/m² of well-composted manure in late summer or fall before planting. Other organic materials such as weed-free straw may be used but these materials should be well decomposed by planting time. For more information on organic matter see *Soil Management* at ontario.ca/crops.

pH requirements

An acceptable soil pH for currants and gooseberries is between 5.5 and 7.0. A slightly acid soil (pH 6.1–6.6) is best. Liming of soil may be required to raise soil pH to 6.1.

- If lime is needed, apply at least six to twelve months before planting. For more information on lime, consult *Soil pH and Liming* on page 31. Micronutrients may become limiting when soil pH is falls outside the recommended range.

Fertilizer before planting

- Work phosphorus and potassium fertilizer into the soil in early spring a few days before planting.
- Incorporate nitrogen before planting or apply in a band around the bush several weeks after planting. Apply fertilizer at least 30 cm away from the base of the bush to avoid burning roots with the nitrogen.
- If planting takes place in the fall, incorporate required phosphorus before planting but delay application of nitrogen and potassium until the following spring.

Nitrogen (N)

- Incorporate or band 5 g of actual nitrogen per bush in the planting year.

Phosphorus (P)

- Test the soil before planting and incorporate the required amount of phosphorus according to the soil test results. See Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, on page 90, for more information. Phosphorus must be incorporated prior to planting to correct phosphorus deficiencies. Phosphorus does not move easily through the soil to the roots. This makes it difficult to correct a problem after the crop is planted. Excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc.

Potassium (K)

- Test the soil before planting and apply the required amount of potassium according to the soil test results. See Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, on page 90.
- Currants and gooseberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60). Use sulphate of potash or sulphate of potash magnesia instead.

Fertilizer in established plantings

- Apply fertilizer early each spring according to soil tests. If phosphorus and potassium are not broadcast over the entire area, reduce rates to the percentage of area that will receive fertilizer.
- If the fertilizer is banded, band 30 cm from the base of the plant.

Nitrogen (N)

- Apply 10 g nitrogen per bush in the year after planting. In subsequent years, apply 20 g per bush.

Potassium (K)

- Apply as according to soil test or assume a moderate level and apply as indicated in Table 5-3. *Phosphorus and Potassium Requirements for*

Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries, on page 90.

Raspberries

Raspberries have a fine, fibrous root system. They prefer a deep, well-drained soil. Raspberry soils need good water retention ability and a high organic matter content, approximately 3%. For more information on organic matter, see *Soil Management* at ontario.ca/crops.

pH requirements

Raspberries grow best at a soil pH of 5.5–6.5, although they can grow well in soils with a higher pH. Liming of soil may be required to raise soil pH to 6.1.

- If lime is needed, apply at least 12 months before planting. For more information on lime, consult *Soil pH and Liming* on page 31. Micronutrients may become limiting when soil pH falls outside the recommended range.

Fertilizer for raspberries

Nitrogen (N)

Recommended nitrogen rates are noted in Table 5-5. *Recommended Nitrogen Rates for Raspberries*, on this page. Avoid the application of excessive nitrogen. It can reduce the number of berries per cane and cause excessive vegetative growth. Sources of nitrogen and nitrogen equivalents are noted in Table 3-10. *Fertilizer Materials: Primary Nutrients*, on page 35.

- For summer and fall-bearing raspberries, apply nitrogen in early spring (late March–early April). Late applications may lead to winter injury. For fall bearing raspberries, winter injury is not a concern since canes are removed each spring. However, delayed ripening is a potential problem where nitrogen is applied in excess.

TABLE 5-5. Recommended Nitrogen Rates for Raspberries

	kg N per ha per season
Planting year	30–40
Second year	40–60
Third and following years	45–75
Use the lower rates on non-irrigated crops and heavier soils. Apply higher rates to irrigated crops and sandier soils. See Appendix C. <i>Accredited Soil-Testing Laboratories in Ontario</i> , on page 211.	

Phosphorus (P) and Potassium (K)

- Use a soil test to determine the need for phosphorus and potassium before planting. Apply the required amount of phosphorus and potassium according to the soil test.
- Incorporate phosphorus prior to planting to correct phosphorus deficiencies. Phosphorus does not move readily through the soil from the surface application.
- Do not apply more phosphorus than is required. Excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc.
- If the soil test recommends high rates of potash, use sulphate of potash (0-0-50) or sulphate of potash magnesia (0-0-22). Raspberries are sensitive to high chlorides. Some root injury has been observed on sandy soils where muriate of potash (potassium chloride, 0-0-60) has been used at a high rate. For sources of phosphorus and potash, refer to Table 3-10. *Fertilizer Materials: Primary Nutrients*, on page 35.
- Once plants are established, take soil samples from where plants are rooted, rather than from between the rows. Complete soil sampling every two to three years.

Leaf analysis

- Collect fully expanded mature raspberry leaves taken from fruiting canes in late July. See Table 5-6. *Ranges for Nutrient Levels in Raspberry Leaves*, on page 93. These ranges provide a guide for interpretation of results. Variation can occur because of cultivars, soil type and cultural practices.

TABLE 5-6. Ranges for Nutrient Levels in Raspberry Leaves

Element	Range
nitrogen (N)	2.0–3.5%
phosphorus (P)	0.2–0.5%
potassium (K)	1.0–2.0%
calcium (Ca)	0.8–2.5%
magnesium (Mg)	0.25–0.5%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
copper (Cu)	5–20 ppm
boron (B)	20–60 ppm

See Appendix C. *Accredited Soil-Testing Laboratories in Ontario*, on page 211, for a list of laboratories that provide leaf analysis.

One year before planting strawberries and raspberries

Adjust soil pH and organic matter at least one year before planting. Plant a weed-smothering cover crop and incorporate it back into the soil to build up organic matter. Liberally apply well-composted manure (45 tonnes of cattle manure per ha) and incorporate into the soil the year before planting. Test the field soil for phosphorus, potassium, magnesium and pH.

See also *Manure nitrogen*, on page 35, *Soil testing*, on page 27, and Appendix C. *Accredited Soil-Testing Laboratories in Ontario*, on page 211.

Further information can be found under *Soil Management*, and *Adaptation and Use of Cover Crops*, at ontario.ca/crops.

Strawberries

Strawberries are shallow-rooted, perennial plants. Heavy demands are placed on the root system, especially in the short period when berries develop. Strawberries require well-drained soils with 2% or higher organic matter and high fertility. Provide an optimum environment for strawberry root growth to obtain a profitable, perennial planting.

pH requirements

The optimum soil pH for strawberry production is 6.0–6.5. Strawberries will grow at a wider range of soil pH, however some micronutrients become less

available outside this range, particularly when soil pH is above 7.0. A soil pH below 5.6 on clay loam and below 6.1 on sandy loam should be adjusted upwards by applying lime the year before planting. For more information on pH, consult *Soil pH and Liming*, on page 31.

Careful and detailed planning is important prior to planting.

Fertilizer for new plantings (the planting year)

Phosphorus (P)

- Use soil test results to determine the best rate of phosphorus to apply. Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, on page 90, shows soil test values and fertilizer requirements for new strawberry plantings.
- Work phosphorus into the soil before you plant. Soils differ in the amount of phosphorus available to plants. Generally, fields cultivated for a long time require less phosphorus than recently developed fields.

Starter Solutions:

- To help the plant establish, particularly if the soil is cold, use a starter fertilizer solution. The amount of phosphorus available is significantly reduced when soil temperatures are low.
- Use a starter solution high in phosphorus such as 10-52-10, 6-24-6 or 10-24-0. Follow the manufacturer's suggested application rate.

Potassium (K)

- Use soil test results to determine the best rate of potassium to apply. Incorporate potassium into soil before planting. Side dressing of potassium is not generally recommended.

Nitrogen (N)

- Nitrogen can be applied with the P and K or as a side dressing two to three weeks after planting. Apply 50 kg of N per ha. See Table 3-10. *Fertilizer Materials: Primary Nutrients*, on page 35, for nitrogen content of fertilizers.

- Apply an additional 25–35 kg N per ha in mid-August to further invigorate plants as they initiate fruit buds for the next year's crop.
- Use whatever form of nitrogen is economical. Brush pelleted forms, such as ammonium nitrate, off the leaves to prevent burning. Do not apply when leaves are wet.
- Urea forms of nitrogen may volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporation of urea prevents this problem.

Strawberries require annual applications of nitrogen. The timing of nitrogen application is as important as the rate of nitrogen. Improper timing and/or rates of nitrogen may lead to an increase in winter injury, softer fruit, and higher incidence of disease.

- Adjust nitrogen rates proportionately if manure was applied. See Table 3-12, *Average Fertilizer Replacement Values For Different Types Of Manure*, on page 36.
- For more information about food safety and the environmental effect of manure application, please see *Use manure responsibly* and *Manure and food safety*, on page 35, for more details.

Fertilizer for established plantings

Nitrogen (N)

Do not apply nitrogen in the spring, particularly on vigorous varieties. Spring applications cause extra vegetative growth and vigour, which results in softer fruit and dense foliage canopies. This increases the potential for botrytis fruit rot. Although spring-applied nitrogen may increase berry size, it also delays maturity by a day or two.

Benefits have been reported from the application of low rates of nitrogen (10–20 kg N per ha) to coarse-textured soils in the spring after mulch removal. Established fields on sandy soils or fields suspected of having winter injury might benefit from light spring applications of nitrogen. Experiment with spring-applied nitrogen on a small scale.

- The best time to apply nitrogen in established fields is at renovation. After you mow the foliage, apply 50 kg N per ha using whatever form of nitrogen is economical. See Table 5-7, *Recommended Nitrogen (N) Rates for Strawberries*, on this page.

- Brush pelleted forms such as ammonium nitrate off the leaves to prevent burning. Do not apply nitrogen when leaves are wet. Urea forms of nitrogen can volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporation of urea prevents this problem.
- Apply an additional 25–35 kg N per ha in mid-August to assist the development of next year's fruit buds.
- Ensure soils are well irrigated after renovation, throughout the summer and in early fall. Adequate soil moisture is needed to optimize nitrogen uptake.

Phosphorus (P)

- If a soil test shows phosphorus is needed, apply at renovation with nitrogen and potassium.
- Excessive phosphorus levels may cause zinc deficiency, especially on sandy soils.

Potassium (K)

- Apply potassium, as determined by a soil test, at renovation with nitrogen and phosphorus. This allows incorporation. Use soil tests and leaf analysis to determine what rate to apply.
- Excessive levels of potassium induce magnesium deficiency, particularly on sandy soils.

TABLE 5-7. Recommended Nitrogen (N) Rates for Strawberries

	Before planting or 2–3 weeks after planting	Renovation (after harvest)	Mid-Aug.
Planting years	50 kg N per ha		25–30 kg N per ha
Established plantings		50 kg N per ha	25–30 kg N per ha

Leaf analysis

Leaf analysis can help assess the nutrient status of strawberry plants and more accurately determine fertilizer requirements.

- Take leaf samples by July 1 for fruiting or August 20 for non-fruiting plantings. Collect at least 50 fully expanded, recently matured leaves with petioles removed. Sample different varieties and plantings separately.

- See Table 5-8. *Optimum Nutrient Level Range of Strawberry Leaves*, on this page, for interpretation of leaf analysis values. For more information, refer to OMAFRA Factsheet, *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

TABLE 5-8. Optimum Nutrient Level
Range of Strawberry Leaves*

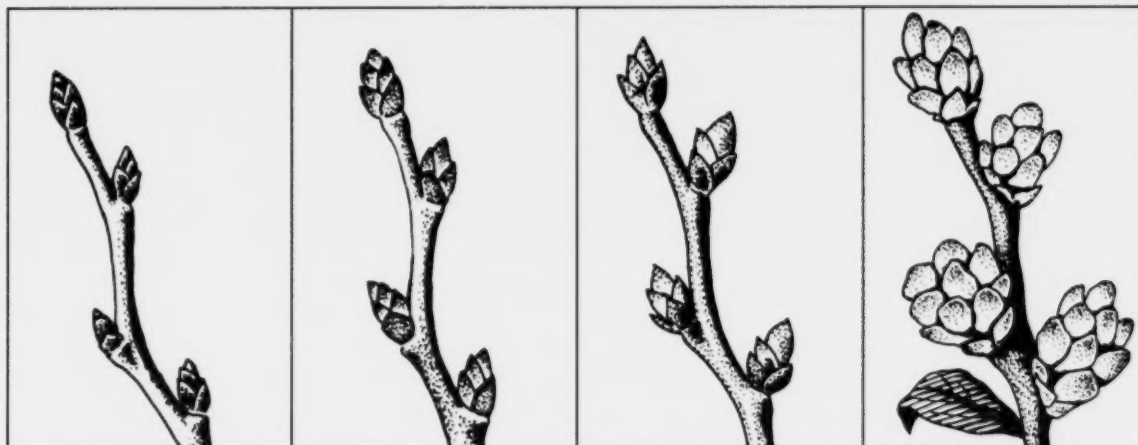
Nutrient	Optimum Range
nitrogen (N)	2.0–3.0%
phosphorus (P)	0.20%–0.50%
potassium (K)	1.5%–2.5%
calcium (Ca)	0.5%–1.5%
magnesium (Mg)	0.25%–0.50%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
boron (B)	20–60 ppm

* Fully expanded, recently matured strawberry leaves with petioles removed, collected before July 1 in fruiting fields and before Aug. 20 in non-fruiting fields.
See Appendix C, *Accredited Soil-Testing Laboratories in Ontario*, on page 211, for laboratories that provide leaf analysis.

Micronutrients for Berry Crops

Deficiencies of micronutrients or trace elements are not widespread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Apply only the deficient nutrient in sufficient quantities to correct the problem. Leaf analysis is more effective than soil analysis to evaluate a crop's micronutrient status. See *Micronutrients*, on page 40, for additional information.

FIGURE 5-1. Blueberry Growth Stages



Dormant

Bud Swell

Green Tip

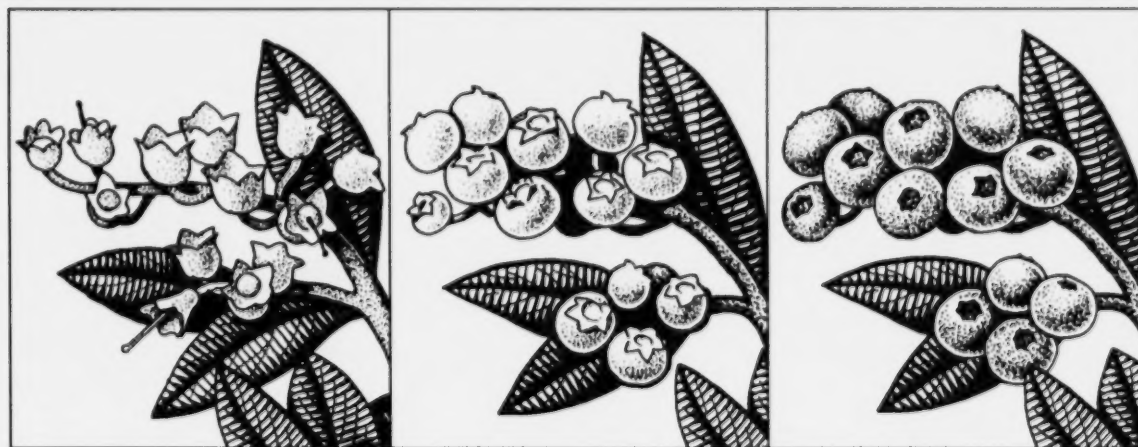
Bud Cluster



Pink Bud

Bloom

Petal Fall



Calyx

Green Fruit

Fruit Ripening

Blueberry Calendar

Consult the product label for suggested water volumes. For mature highbush blueberries, use 700–1,000 L of water per ha unless otherwise noted on the label.

Products are listed according to insecticide and fungicide family groups. Use products from different family groups to prevent pest resistance.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant (late winter)			
Scale insects Lecanium scale	<ul style="list-style-type: none"> Guardsman Dormant Oil Spray Lime Sulphur plus Dormant Oil Spray 	20 L oil/ 1,000 L water 50 L Lime Sulphur plus 12.50 L oil/ 1,000 L water	Apply when plants are dormant. Spray to the point of run-off, cover completely. Do not use within 10 days of Bravo, Captan or Maestro, or phytotoxicity may result. Do not use within 48 hours of freezing temperatures.
Early Spring, prior to bud break			
Phytophthora root rot	<ul style="list-style-type: none"> Ridomil Gold 480 SL 	Banded: 37 mL/100 m	If phytophthora root rot has been identified, apply 37 mL/100 m of row to the soil surface in a 1 m band centered over the row. Apply in at least 2,000 L of water per ha.
Bud swell to pink bud			
Mummy berry (<i>Monilinia</i>)	<ul style="list-style-type: none"> Funginex DC Topas 250 E or Mission 418 EC 	1.70 L 500 mL 300 mL	Cultivate before bud break to bury overwintering inoculum. Monitor for trumpet-shaped structures erupting from mummified berries on the ground. Spray to prevent primary infection of blueberry shoots. Make the first application when the flower buds swell and spray once or twice more at 10–14 day intervals until first bloom. Funginex: Do not spray after pink bud stage. Topas or Mission: Maximum two applications per season.
Leaf tiers	<ul style="list-style-type: none"> Decis 5 EC 	150 mL	Damage occurs very early. If leaf tier was a problem in the past, spray at the bud cluster stage as flower buds begin to swell and pink tissue becomes visible.
Green tip			
Phomopsis stem canker Anthracnose fruit rot	<ul style="list-style-type: none"> Cabrio EG Pristine WG Pristine WG Bravo 500 	1.00 kg 1.30 kg* 1.60 kg* 7.20 L	Apply fungicides at this time to prevent twig blights and reduce overwintering inoculum. *Pristine: Use 1.3 kg/ha for anthracnose fruit rot and 1.6 kg/ha for phomopsis stem canker. Pristine and Cabrio: Both include active ingredients in the same fungicide family. Maximum two consecutive applications, then alternate with fungicides from different families. Bravo: Will also control alternaria fruit rot.
Pink bud			
Anthracnose fruit rot Phomopsis stem canker	<ul style="list-style-type: none"> Cabrio EG Pristine WG Pristine WG Bravo 500 	1.00 kg 1.30 kg* 1.60 kg* 7.20 L	Apply fungicides at this time to prevent twig blights. *Pristine: Use 1.3 kg/ha for anthracnose fruit rot and 1.6 kg/ha for phomopsis stem canker. Pristine and Cabrio: Both include active ingredients in the same fungicide family. Maximum two consecutive applications then alternate with fungicides from different families. Bravo: Will also control alternaria fruit rot.
DO NOT APPLY INSECTICIDES WHILE BLUEBERRIES ARE IN BLOOM. SEE BEE POISONING ON PAGE 192.			

Diseases and Insects	Materials	Amount/ha	Comments
First bloom			
Anthracnose fruit rot	• Cabrio EG	1.00 kg	Pristine and Cabrio: Both include active ingredients in the same fungicide family. Maximum two consecutive applications then alternate with fungicides from different families.
	• Pristine WG	1.30 kg	
	• Switch 62.5 WG	775 g	
Botrytis twig and blossom blight	• Supra Captan 80 WDG or Maestro 80 DF	2.25 kg 2.25 kg	Fungicides for botrytis blights are more important when wet weather occurs. Repeat at 7–10 day intervals through bloom if weather is wet. Choose fungicides from different families to reduce the development of resistant strains. Ferbam: Do not use later than mid-bloom. Serenade Max: Provides suppression, rather than control, of botrytis blossom blight and fruit rot. Expect best results from multiple applications or when used in rotation with other products.
Botrytis fruit rot (grey mould)	• Ferbam 76 WDG	3.75 kg	
	• Elevate 50 WDG	1.70 kg	
	• Lance WDG	560 g	
	• Pristine WG	1.30 kg	
	• Switch 62.5 WG	775 g	
	• Serenade Max	3.00 kg	
Petal fall			
Cherry fruitworm	• Malathion 25 W	2.25 kg	Moths lay eggs on developing fruit and larvae tunnel into fruit. Use pheromone traps to monitor moth activity and to time the spray more accurately. Sevin or Malathion: Apply 5–7 days after trap catches peak. A second insecticide is required if trap catches remain elevated seven days after application. Dipel: Spray at peak trap catch and continue at 3–7 day intervals, to a maximum of four applications. Dipel is less effective than other products and unstable in bright sunlight. Apply on a cloudy day or in the evening. Malathion: Also controls aphids.
Cranberry fruitworm	• Sevin XLR	4.00 L	
	• Dipel 2X DF	1.68 kg	
Anthracnose fruit rot	• Cabrio EG	1.00 kg	Most fruit infections occur in the bloom to green fruit stage. Infected fruit soften near harvest time and orange spore masses develop on the fruit. Alternate with fungicides from different families. Pristine and Cabrio: Both include active ingredients in the same fungicide family. Make no more than two consecutive applications, then alternate with fungicides from different families. Bravo: Also controls alternaria fruit rot. Bravo may cause fruit injury if applied to green fruit.
	• Pristine WG	1.30 kg	
	• Switch 62.5 WG	775 g	
	• Bravo 500	7.20 L	
Phomopsis stem canker	• Cabrio EG	1.00 kg	Pristine and Cabrio: Both include active ingredients in the same fungicide family. Make no more than two consecutive applications, and then alternate with fungicides from different families. Bravo: Also controls alternaria fruit rot. Bravo may cause fruit injury if applied to green fruit.
	• Pristine WG	1.60 kg	
	• Bravo 500	7.20 L	
European chafer larvae	• Admire 240 F	1.20 L	Do not apply during bloom. Apply just prior to egg hatch (shortly after adults are active) to damp soil around bushes and to grass covered areas around blueberry field. Apply in 200 L water per ha. Move the product into the root zone with 5–10 mm irrigation within 24 hours of application but avoid over watering. Maximum one application per season, at petal fall, fruit ripening or after harvest.
Japanese beetle larvae	• or Alias 240 WG	1.20 L	

Diseases and Insects	Materials	Amount/ha	Comments
Fruit ripening			
Botrytis fruit rot (grey mould)	• Supra Captan 80 WDG or Maestro 80 DF	2.25 kg 2.25 kg	<p>Spray at 7–10 day intervals if botrytis grey mould was not well controlled during bloom. Choose fungicides from different chemical families to reduce the development of resistant strains.</p> <p>Serenade Max: Provides suppression, rather than control of botrytis fruit rot. Expect best results from multiple applications or when used in rotation with other products.</p>
	• Elevate 50 WDG	1.70 kg	
	• Lance WDG	560 g	
	• Switch 62.5 WG	775 g	
	• Serenade Max	3.00 kg	
Anthracnose fruit rot	• Switch 62.5 WG	775 g	Most infections take place during bloom. Fungicides at this time are not necessary if good control was achieved earlier.
European chafer larvae Japanese beetle larvae	• Admire 240 F or Alias 240 WG	1.20 L 1.20 L	Do not apply during bloom. Apply just prior to egg hatch (shortly after adults are active) to damp soil around bushes and to grass covered areas around blueberry field. Apply in 200 L water per ha. Move the product into the root zone with 5–10 mm irrigation within 24 hours of application but avoid over watering. Maximum one application per season, at petal fall, fruit ripening or after harvest.
Blueberry maggot	• Imidan 50 WP	2.25 kg	<p>Monitor for blueberry maggot using yellow sticky traps.</p> <p>Ontario is considered free from blueberry maggot, except for regulated areas. Growers in regulated areas (including Wainfleet and Charlotteville townships) should spray for this pest. Growers outside regulated areas should consider border sprays and practice best management practices to prevent infestation. For more information, see <i>Blueberry Maggot</i> at ontario.ca/crops.</p> <p>Apply the first spray when first blueberry maggots are trapped or when berries begin to turn blue, about July 5–15, depending on the area and season. Apply a second spray about 5–12 days later, depending on the product. Protection is needed as long as adults are active. Imidan and Cygon provide 10–12 days protection under normal conditions. Residual activity of Sevin and Malathion is much shorter.</p> <p>Cygon, Lagon: Maximum two applications per season. Do not use on crops destined for USA markets.</p> <p>Imidan: Maximum two applications per season.</p> <p>GF-120 NF: This is a bait formulation that requires large droplet size (4–6 mm); specialized application equipment may be needed. Begin applications when first blueberry maggot flies are trapped or 2–3 weeks before fruit begins to ripen. Repeat application at least every 7 days. GF-120 will lose effectiveness if exposed to rain or overhead irrigation.</p>
	• Cygon 480 (highbush)	830 mL	
	• Cygon 480 (lowbush)	580 mL	
	• Lagon 480 E (highbush)	825 mL	
	• Lagon 480 E (lowbush)	600 mL	
	• Malathion 25 W	2.25 kg	
	• Sevin XLR	4.00 L	
	• GF-120 NF	1.50 L	

Blueberry maggot is a regulated pest; infestations must be reported to the Canadian Food Inspection Agency.

Blueberry maggot can spread to new areas in soil, harvest containers, or when infested fruit is purchased from another region and dumped on your farm.

Use best management practices to prevent spread of blueberry maggot to new areas.

See ontario.ca/crops.

TABLE 5-9. Products Used on Blueberries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval	Minimum re-entry	Maximum # applications per season
Admire 240 F	imidacloprid	neonicotinoid	14 days	24 hours	1
Alias 240 WG	imidacloprid	neonicotinoid	14 days	24 hours	1
Bravo 500	chlorothalonil	chloronitrile	54 days	48 hours	3
Cabrio EC	pyraclostrobin	strobilurin	29 days	29 days for hand harvest, when dried for other activities	4
Cygon 480	dimethoate	organophosphate	15 days		2
Decis 5 EC	deltamethrin	pyrethroid	14 days		
Dipel 2X DF	<i>Bacillus thuringiensis</i>	B.t. microbial	1 day		4
Elevate 50 WDG	fenhexamid	hydroxyaniline	1 day	4 hours	4
Ferbam 76 WDG	ferbam	dithiocarbamate	40 days		
Funginex DC	triforine	piperazine	60 days	48 hours	3
GF-120 NF	spinosad	spinosyn	0		5
Guardsman Dormant Oil Spray	mineral oil				1
Imidan 50 WP	phosmet	organophosphate	15 days		2
Lagon 480 E	dimethoate	organophosphate	15 days		2
Lance WDG	boscalid	anilide	0 days	4 hours	4
Lime Sulphur plus Dormant Oil Spray	calcium polysulphide	inorganic			1
Maestro 80 DF	captan	phthalimide	2 days	72 hours	
Malathion 25 W	malathion	organophosphate	1 day		
Mission 418 EC	propiconazole	triazole (DMI)	60 days	72 hours	2
Pristine WG	boscalid + pyraclostrobin	anilide carboxamide + Qol	0 days	29 days for hand harvest, when dried for other activities	4
Ridomil Gold 480 SL	metalaxyl M and S isomer	phenyl amide	80 days	12 hours	1
Serenade Max	<i>Bacillus subtilis</i>	B.t. microbial	0 days		
Sevin XLR	carbaryl	carbamate	2 days		
Supra Captan 80 WDG	captan	phthalimide	2 days	72 hours	
Switch 62.5 WG	cyprodinil + fludioxonil	anilinopyrimidine + phenyl pyrroles	1 days	12 hours	3
Topas 250 E	propiconazole	triazole (DMI)	60 days	72 hours	2

TABLE 5-10. Activity of Fungicides on Blueberry Diseases

Ratings in shaded cells indicate the disease is listed on the product label for control or suppression. Use fungicides only for diseases listed on the product label for the crop and for the disease. Additional information is provided in this table to assist the grower in choosing the best fungicide for control of diseases listed on the product label.

Fungicide group	Product	Mummy berry (shoot blight)	Phomopsis stem canker	Anthraxnose fruit rot	Botrytis fruit rot	Alternaria fruit rot	Phytophthora root rot
M2	Ferbam 76 WDG	+			+	+	0
M2	Maestro 80 DF	+	++	++	+ to ++	+	0
M2	Supra Captan 80 WDG	+	++	++	+ to ++	+	0
M4	Bravo 500	0	++	+	+ to ++	+	0
3	Funginex 190 EC	+++	++	0	0	0	0
3	Mission 418 EC	+++	+	0	0	0	0
3	Topas 250 E	+++	+	++	0	0	0
4	Ridomil Gold 480 SL	0	0	0	0	0	+++
7	Lance WDG	0			+++		0
7&11	Pristine WG	++	+++	+++	+++	++	0
9&12	Switch 62.5 WG	++	+	+++	+++	+++	0
11	Cabrio EG	+	+++	+++	+ to ++	++	0
17	Elevate 50 WDG	0	0	0	+++	0	0

Use fungicides only for control of diseases listed on the product label.
 0 = No control; + = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations.
 Blank cell: Effect unknown.

Current and Gooseberry Calendar

Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point.

Products are listed according to insecticide and fungicide family groups. Use of products from different family groups helps prevent pest resistance.

Pests controlled	Materials	Amount	Comments
Just before blossoms open			
DO NOT APPLY INSECTICIDES WHILE CURRANTS OR GOOSEBERRIES ARE IN BLOOM. SEE BEE POISONING ON PAGE 192.			
Leaf spot	<ul style="list-style-type: none"> Ferbam 76 WDG Copper 53 W plus hydrated lime 	6.75 kg/ha 5.0 kg/1,000 L plus 4.0 kg lime/1,000 L	Leaf spots develop on susceptible varieties, reducing yield and vigour. Rake or cultivate to bury old infected leaves before bud-break. Apply fungicides to susceptible varieties at weekly intervals if weather is wet. Do not use Ferbam on gooseberries.
Powdery mildew	<ul style="list-style-type: none"> Microscopic Sulphur 	5.00 kg/ha	Resistant varieties are available, see Table 5-12. <i>Disease Ratings on Selected Currant and Gooseberry Varieties</i> , on page 104. Prune out infected twig tips in fall and avoid excessive nitrogen.
Sawfly (imported currant fruitworm)	<ul style="list-style-type: none"> Diazinon 50 W or Diazinon 500 E 	1.00 kg/1,000 L water 1.00 L/1,000 L water	Adults lay eggs in May and June. Green larvae quickly devour foliage at the green fruit stage. Gooseberries are the preferred host; black currants are not attacked. Do not apply Diazinon after the first bloom opens.
Blister aphid	<ul style="list-style-type: none"> Malathion 25 W 	2.50 kg/1,000 L water	Aphids feeding on new growth can cause leaf curl and red blisters. Spray if aphids are abundant. Ensure good coverage of undersides of curled leaves.
Botrytis grey mould	<ul style="list-style-type: none"> Pristine WG Lance WDG Elevate 50 WDG Serenade Max 	1.30 kg/ha 560 g/ha 1.70 kg/ha 3.00 kg/ha	Botrytis infection during bloom causes early fruit drop, or "run-off" in currants. Apply fungicides at 7–10 day intervals during bloom. Choose fungicides from different chemical families to reduce the development of resistant strains of <i>Botrytis</i> . Pristine and Lance: Both include active ingredients in the same fungicide family. Do not alternate Pristine with Lance. Serenade Max: Provides suppression, rather than control, of <i>botrytis</i> . Expect best results when used in multiple applications or rotation with other products.
Bloom			
Botrytis grey mould	<ul style="list-style-type: none"> Pristine WG Lance WDG Elevate 50 WDG Serenade Max 	1.30 kg/ha 560 g/ha 1.70 kg/ha 3.00 kg/ha	See comments above.
Postbloom: as soon as bloom is complete			
Leaf spot	<ul style="list-style-type: none"> Ferbam 76 WDG Copper 53 W plus hydrated lime 	6.75 kg/ha 5.0 kg/1,000 L plus 4.0 kg lime/1,000 L	Apply at weekly intervals in the spring if weather is wet, but not within 14 days of harvest. Do not use Ferbam on gooseberries.
Powdery mildew	<ul style="list-style-type: none"> Microscopic Sulphur 	5.00 kg/ha	Resistant varieties are available, see Table 5-12. <i>Disease Ratings on Selected Currant and Gooseberry Varieties</i> , on page 104. Prune out infected twig tips in fall and avoid excessive nitrogen. If warm and humid conditions persist, repeat weekly until fruit begins to colour.

Pests controlled	Materials	Amount	Comments
Currant fruit fly	• Malathion 25 W	2.50 kg/1,000 L water	Larvae infest fruit, causing it to ripen prematurely. Spray to control adult flies, which lay eggs on green fruit. Spray where this pest has been a problem in the past or use yellow sticky traps to monitor for adult activity. Make two applications, 10 days apart. Malathion is most effective when temperature is above 20°C.
10 days after postbloom spray			
Leaf spot	• Ferbam 76 WDG	6.75 kg/ha	Apply at 7–10 day intervals if weather is wet, but not within 14 days of harvest. Do not use Ferbam on gooseberries.
	• Copper 53 W plus hydrated lime	5.0 kg/1,000 L plus 4.0 kg lime/1,000 L	
Currant fruit fly	• Malathion 25 W	2.50 kg/1,000 L water	Malathion: Is most effective when temperature is above 20°C.
Postharvest			
Leaf spot	• Ferbam 76 WDG	6.75 kg/ha	Do not use Ferbam on gooseberries.
	• Copper 53 W plus hydrated lime	5.0 kg/1,000 L plus 4.0 kg lime/1,000 L	
Aphids Leafhoppers	• Malathion 25 W	2.50 kg/1,000 L water	Monitor for leaf curling on new growth. If these pests are present, spray red and white currants immediately after fruit is picked.

TABLE 5-11. Products Used on Currants

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labeled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation beneficial insects.

Product name	Common Name	Group	Preharvest interval	Minimum re-entry	Maximum # applications per season
Copper 53 W plus hydrated lime	tribasic copper sulphate	inorganic	1 day		
Diazinon 500 E	diazinon	organophosphate	Do not use after first bloom		
Diazinon 50 W	diazinon	organophosphate	Do not use after first bloom		
Elevate 50 WDG	fenhexamid	hydroxaniline	1 day	4 hours	4
Ferbam 75 WDG	ferbam	dithiocarbamate	14 days		
Lance WDG	boscalid	anilide	0 day	4 hours	4
Malathion 25 W	malathion	organophosphate	3 days		
Microscopic Sulphur	sulphur	inorganic	1 day	24 hours	8
Pristine WG	boscalid + pyraclostrobin	anilide carboxamide + QoI	0 days	29 days for hand harvest, when dried for other activities	4
Serenade Max	<i>Bacillus subtilis</i>	B.t. microbial	0 days		

TABLE 5-12. Disease Ratings on Selected Currant and Gooseberry Varieties

Type	Variety	Mildew Resistance	Rust Resistance ¹
black currant	Ben Alder	resistant ²	very susceptible ²
black currant	Ben Connan	resistant ²	moderately resistant ²
black currant	Ben Sarek	resistant ²	moderately resistant ²
black currant	Titania	immune	immune
red currant	Red Lake	susceptible ⁴	susceptible ³
red currant	Rovada	resistant ⁴	moderately resistant ³
red currant	Jonkheer van Tets	moderately resistant ³	resistant ⁴
gooseberry	Captivator	moderately resistant ³	
gooseberry	Invicta	moderately resistant ³	moderately resistant ³
gooseberry	Hinnonmaki Red	resistant ⁴	moderately resistant ³

¹ Resistant: Does not show symptoms of rust (only Titania has genetic resistance).

Moderately resistant: Shows symptoms at low frequency, yield not affected.

Susceptible: Noticeable levels of rust infection, not affecting yield.

Very susceptible: Severe infection, affecting yield.

Source:

² Adam Dale, *HortTechnology* 10(3) 2000, page 553.

³ Hummer and Barney, *HortTechnology* 12(3) 2002 page 382–383, or *Currants, Gooseberries, Jostaberries, Guide for Growers*, Food Products Press 2005.

⁴ Dick McGinnis, McGinnis Berry Crops, B.C., personal communication.

Raspberry Calendar

Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point.

Products are listed according to insecticide and fungicide family groups. Use products from different family groups to help prevent pest resistance.

Diseases and Insects	Materials	Amount	Comments
Delayed dormant to green tip			
Spur blight Cane blight	• Lime sulphur	35 L/1,000 L water	Reduces overwintering inoculum. This is the first step in a good disease control program. Spray enough water to drip off the plants. Do not use lime sulphur later than ¼-inch green.
Prebloom (until blossoms open)			
Anthracnose Spur blight	• Ferbam 76 WDG	2.25 kg/1,000 L water	Protect new growth. Apply when new canes are 25–30 cm tall and again just before first bloom.
	• Tanos 50 DF	840 g/ha	
Powdery mildew	• Senator 70 WP	500 g/1,000 L water or 1.10 kg/ha	In problem areas, spray when mildew is first observed. Repeat in 7–10 days. For resistance management, maximum two applications per season.
Raspberry sawfly	• Diazinon 50 W	1.00 kg/1,000 L water	These green bristly larvae feed between the veins on new growth causing long holes and shredding. Apply when damage appears, but before first bloom. Diazinon also controls aphids and raspberry fruit worm.
Raspberry fruitworm	• Malathion 25 W	4.50 kg/1,000 L water	These small brown beetles feed on new growth and blossom clusters. Larvae infest fruit cup. Spray to control adults when damage appears but before first bloom. Repeat in seven to ten days where there is a history of injury.
	• Diazinon 50 W	1.00 kg/1,000 L water	
Leafrollers	• Foray 48BA or Bioprotec CAF or Dipel 2X DF	2.80 L/ha 2.80 L/ha 550 g/ha	Leafrollers are not usually a problem in Ontario. Susceptible varieties include Chilliwick, Chilcotin, Tulameen and Comox and other varieties from the Pacific Northwest. Do not apply these as dilute sprays Foray 48 BA and Bioprotec CAF: Apply in no more than 600 L water per ha.
Clipper weevil	• Malathion 25 W	4.50 kg/1,000 L water	Increasingly common, especially where strawberries are also grown. Clipped buds and small round holes in petals indicate clipper weevil activity.
Two-spotted spider mite	• Apollo SC • Kelthane 50 W	500 mL/ha 2.00 kg/ha	Alternate miticides from year to year. Thorough spray coverage of the lower leaf surface is required. Beneficial mites can be introduced to prevent mite build-up. Kelthane: Apply when mite populations are beginning to build and mites are mostly in the nymph stage. Maximum one application per season. Apollo: Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage. Maximum one application per season.

Diseases and Insects	Materials	Amount	Comments
Bloom			
DO NOT APPLY INSECTICIDES WHILE RASPBERRIES AND BLACKBERRIES ARE IN BLOOM. SEE BEE POISONING ON PAGE 192.			
Botrytis grey mould	<ul style="list-style-type: none"> • Rovral • Supra Captan 80 WDG or Maestro 80 DF • Elevate 50 WDG • Lance 50 WDG • Pristine WG • Switch 62.5 WG • Serenade Max 	2.00 kg/ha 2.50 kg/ha 2.50 kg/ha 1.70 kg/ha 560 g/ha 1.30 kg/ha 775 g/ha 3.00 kg/ha	<p>Bloom is the most important time to control botrytis grey mould. Begin at 5–10% bloom and, if the weather is wet, repeat every seven days. Choose fungicides from different chemical families to reduce the development of resistant strains.</p> <p>Captan or Maestro: Also control spur blight. The rate for Supra Captan 80 WDG and Maestro 80 DF on blackberry is 2.25 kg/ha.</p> <p>Pristine and Lance: Both include active ingredients in the same family. Do not alternate Pristine with Lance.</p> <p>Serenade Max: Provides suppression, rather than control of botrytis grey mould. Expect best results from multiple applications or when used in rotation with other products.</p>
Green fruit			
Anthracnose Spur blight Cane botrytis	• Tanos 50 DF	840 g/ha	Ensure spray coverage of primocanes in the row. Keep rows narrow by mowing primocanes as they emerge at the row edges. Captan and Maestro used at this timing will also control spur blight.
Leafrollers	• Foray 48BA or Bioprotec CAF or Dipel 2X DF	2.80 L/ha 2.80 L/ha 550 g/ha	<p>Leafrollers are not usually a problem in Ontario. Susceptible varieties include Chilliwack, Chilcotin, Tulameen and Comox and other varieties from the Pacific Northwest.</p> <p>For best results using B.t. products (Dipel, Foray, Bioprotec) acidify spray mix to below pH 7.0 and apply on cloudy days or at dusk.</p> <p>Do not apply these as dilute sprays</p> <p>Foray 48 BA and Bioprotec CAF: Apply in no more than 600 L water per ha.</p>
Japanese beetle	• Sevin XLR	5.25 L/ha	Apply when adults appear and repeat as necessary at 7–10 day intervals. The preharvest interval is 11 days.
Leafhoppers Rose chafers	• Malathion 25 W	4.50 kg/1,000 L water	Potato leafhopper can be especially problematic after nearby hay fields are mowed. Leafhoppers feed on primocane leaves and cause new growth to turn yellow and curl under. Monitor for small green nymphs on lower leaf surface.
Preharvest			
Botrytis grey mould	<ul style="list-style-type: none"> • Rovral • Supra Captan 80 WDG or Maestro 80 DF • Elevate 50 WDG • Lance 50 WDG • Pristine WG • Switch 62.5 WG • Serenade Max 	2.00 kg/ha 2.50 kg/ha 2.50 kg/ha 1.70 kg/ha 560 g/ha 1.30 kg/ha 775 g/ha 3.00 kg/ha	<p>Although bloom is the most important time to control botrytis grey mould, preharvest sprays are required if the weather is wet. Choose fungicides from different chemical families to reduce the development of resistant strains.</p> <p>Captan or Maestro: Also control spur blight. The rate for Supra Captan 80 WDG and Maestro 80 DF on blackberry is 2.25 kg/ha.</p> <p>Pristine and Lance: Both include active ingredients in the same family. Do not alternate Pristine with Lance.</p> <p>Serenade Max: Provides suppression, rather than control, of botrytis grey mould. Expect best results from multiple applications or when used in rotation with other products.</p>

Diseases and Insects	Materials	Amount	Comments
Postharvest			
Anthracnose Spur blight Cane botrytis	• Tanos 50 DF	840 g/ha	Apply once or twice after harvest, to protect primocanes. Ensure spray coverage of primocanes in the row. Narrow rows and good weed control will reduce disease pressure in the row by allowing air flow and faster drying.
Leafhoppers	• Malathion 25 W	4.50 kg/1,000 L water	
Powdery mildew	• Senator 70 WP	1.10 kg/ha or 500 g/1,000 L water	Repeat in 14 days if disease becomes evident on new growth. For resistance management, maximum two applications per season.
Two-spotted spider mite	• Agri-Mek 1.9% EC	1.00 L/ha	Alternate miticides between years. Thorough spray coverage of the lower leaf surface is required.
	• Kelthane 50 W	2.00 kg/ha	Beneficial mites can be introduced to prevent mite build-up.
	• Pyramite or Nexter	600 g/ha 600 g/ha	Agri-Mek or Pyramite or Nexter: Do not use before harvest. Kelthane: Apply when mite populations are beginning to build and mites are mostly in the nymph stage. Maximum one application per season.
Special Sprays: Early spring and/or fall			
Raspberry crown borer	• Diazinon 500 E or Diazinon 50 W • Guthion 50 WSB or Sniper	1.00 L/1,000 L water 1.00 kg/1,000 L water 2.25 kg/ha 2.25 kg/ha	If more than 5% of the crowns are infested, apply this spray to lower portions of canes and to the crown area. Treat infested plantings at least two years in a row. Diazinon: Apply diazinon in 4,000–5,000 L of water per ha as a drench to crowns and base of plants. Apply in spring to control young larvae before they tunnel into crowns. Apply when new growth is about 10 cm above ground. Do not apply after first bloom. Guthion or Sniper: Apply in mid-September to mid-October to control young larvae. Apply in 1,600 L of water per ha.
Phytophthora root rot	• Ridomil Gold 480 SL • Aliette WDG	37 mL/100 m of row (Apply in a drench spray to the soil surface in a 1 m band centred over the row. Use at least 2,500 L of water per ha). 5.50 kg/ha	Ridomil: In new plantings, apply as a soil drench after planting and again in mid to late October (before the ground is frozen). In established plantings, apply Ridomil Gold in the fall only. Do not apply in spring to established plantings. Aliette: Aliette WDG is best as a preventive treatment. Maximum four applications per year: two in the spring and two in the fall. <i>Spring application:</i> Apply after bud break at 7 cm of new growth and again 3–4 weeks later. Do not apply within 60 days of harvest. <i>Fall application:</i> Apply when conditions favour disease development (high soil moisture and cool temperatures) and repeat if necessary 3–4 weeks later. The last application should be made at least 30 days before leaf drop. <i>Precautions:</i> Crop phytotoxicity is possible when Aliette is mixed with copper. Care should be taken if mixing Aliette with nitrogen-based foliar fertilizer. Incompatibility with some suspension concentrate formulations can occur.

TABLE 5-13. Products Used on Raspberries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval	Minimum re-entry	Maximum # applications per season
Agri-Mek 1.9% EC	abamectin	avermectin	Use after harvest		2
Aliette WDG	fosetyl al	phosphonate	60 days		4
Apollo SC	clofentezine	tetrazine	15 days	12 hours	1
Bioprotec CAF	<i>Bacillus thuringiensis</i>	B.t. microbial	1 day		
Diazinon 500 E	diazinon	organophosphate	Use only before bloom		
Diazinon 50 W	diazinon	organophosphate	Use only before bloom		
Dipel 2X DF	<i>Bacillus thuringiensis</i>	B.t. microbial	1 day		
Elevate 50 WDG	fenhexamid	hydroxylaniline	1 day	4 hours	4
Ferbam 76 WDG	ferbam	dithiocarbamate	Use only before bloom		3
Foray 48 BA	<i>Bacillus thuringiensis</i>	B.t. microbial	1 day		
Guthion 50 WSB	azinphosmethyl	organophosphate	post-harvest	7 days	1
Kelthane 50 W	dicofol	diphenylethane	7 days		1
Lance 50 WDG	boscalid	anilide	0 days	4 hours	4
Lime Sulphur	lime sulphur	inorganic	Do not use after ¼ inch green		
Maestro 80 DF	captan	phthalimide	2 days	72 hours	
Malathion 25 W	malathion	organophosphate	1 day		
Nexter	pyridaben	pyridazinone	Use after harvest	24 hours	2
Pristine WG	boscalid + pyraclostrobin	anilide carboxamide + Qol	0 days	24 hours	4
Pyramite	pyridaben	pyridazinone	Use after harvest	24 hours	2
Ridomil Gold 480 SL	metalaxyl-M and S	phenyl amide	Use after harvest	12 hours	1
Rovral	iprodione	dicarboximide	1 day	12 hours	8
Senator 70 WP	thiophanate-methyl	benzimidazole	1 day		
Serenade Max	<i>Bacillus subtilis</i>	B.t. microbial	0 days		
Sevin XLR	carbaryl	carbamate	11 days		
Sniper	azinphosmethyl	organophosphate	post-harvest	7 days	1
Supra Captan 80 WDG	captan	phthalimide	2 days	72 hours	
Switch 62.5 WG	cyprodinil + fludioxonil	anilinopyrimidine + phenyl pyrroles	1 day	12 hours	3
Tanos 50 DF	cymoxanil + famoxadone	cyanoacetamide-oximes + Qol	0 days	24 hours	6
Vydate L	oxamyl	carbamate	Use after harvest	48 hours	1

TABLE 5-14. Activity of Fungicides on Raspberry Diseases

Ratings in shaded cells indicate the disease is listed on the product label for control or suppression. Use fungicides only for diseases listed on the product label for the crop and for the disease. Additional information is provided in this table to assist the grower in choosing the best fungicide for control of diseases listed on the product label.

Fungicide group	Product	Anthraco- nose (Elsinoe)	Spur blight	Cane botrytis	Botrytis fruit rot	Raspberry leaf spot	Late leaf rust	Powdery mildew	Phytophthora root rot	Crown gall
M1	Lime Sulphur	+	+	+	0	+	+		0	0
M2	Ferbam 76 WDG	+	+	+	NA		+		0	0
M2	Maestro 80 DF	++	++	+	++	+ to ++	0		0	0
M2	Supra Captan 80 WDG	++	++	+	++	+ to +++	0		0	0
1	Senator 70 WP	++	++	+	0 to +	++	0	++	0	0
2	Rovral WP			+	++		0		0	0
3	Topas 250 E	++	++		++	+++	+++		0	0
4	Ridomil Gold 480 SL	0	0	0	0	0	0	0	+++	0
7	Lance WDG		0		+++		0		0	0
7&11	Pristine WG	+++	+++	+++	+++	+++	+++	+++	0	0
9&12	Switch 62.5 WG			+++	+++			+	0	0
11&27	Tanos DF	++	++	+	+					
17	Elevate 50 WDG		+	+++	+++		0		0	0
33	Aliette WDG	0	0	0	0	0	0	0	++	0
NC	Serenade Max				+			++		

0 = No control; + = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations.
Blank cell = Effect unknown; NA = Not used at the timing for this pest.
* Delayed dormant timing.

TABLE 5-15. Activity of Insecticides on Raspberry Pests

Ratings in shaded cells indicate the pest is listed on the product label for control or suppression. Use insecticides only for insects listed on the product label for the crop and for the insect. Additional information is provided in this table to assist the grower in choosing the best insecticide for control of pests listed on the product label.

Group	Insecticide	Raspberry sawfly	Raspberry fruitworm (beetle)	Leafrollers	Clipper weevil	Leafhoppers	Spider mites	Inch-worms and loopers	Rose chafer	Raspberry crown borer (larvae)	Bee toxicity
1B	Diazinon* (Various Formulations)	+++	+++	++	+	+	0			+++	HT
1B	Guthion or Sniper**	na	na	na	na	na	na	na	na	+++	HT
1B	Malathion 25 W	+++	+++	++	++	++	0	++	++		HT
3	Kelthane 50 W	0	0	0	0	0	++R	0	0	0	S
6	Agri-Mek 1.9% EC	0	0	0	0	0	+++	0	0	0	HT
10	Apollo SC	0	0	0	0	0	++	0	0	0	S
11	Dipel 2X DF	0	0	++	0	0	0	+	0	0	S
11	Foray 48 BA	0	0	++	0	0	0	+	0	0	S
21	Pyramite***	0	0	0	0	0	+++	0	0	0	HT
21	Nexter***	0	0	0	0	0	+++	0	0	0	HT

* Not for use after bloom.

** For use in September-October only.

*** For post harvest use only.

Bee toxicity: HT = highly toxic; MT = moderately toxic; S = relatively safe or non-toxic.

0 = No control; + = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations.

Blank cell = Unknown, NA = Not used at the timing for this pest.

Saskatoon Berry Calendar

Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

Products are listed according to insecticide and fungicide family groups. Use products from different family groups to help prevent pest resistance.

Pest	Product	Rate/ha	Comments
Early bud break			
Saskatoon bud moth Fruit tree leafroller	• Superior 70 Oil	20 L/1,000 L water	Apply in high water volume until all plant surfaces are coated. Do not apply in freezing weather or if frost is expected
Flower bud break			
Saskatoon-juniper rust	• Funginex DC	3.00 L	This disease causes yellow spots and swellings on leaves and fruit. Infections on juniper spread up to 2 km to saskatoons. Prune out rust galls on juniper or remove entire juniper plants to reduce disease pressure. Make one application of Funginex to saskatoons, between flower bud break and white tip.
Entomosporium leaf and berry spot	• Funginex DC • Kumulus DF	3.00 L 7.50 kg	Angular brown spots develop first on lower leaves, causing yellowing, defoliation and fruit cracking. Make one application of Funginex, between flower bud break and white tip. Apply Kumulus at flower bud break and repeat at 10–14 day intervals while disease risk persists. Do not apply if temperatures are over 27°C or leaf injury may result.
White tip			
Saskatoon-juniper rust	• Funginex DC • Topas 250 E or Mission 418 EC	3.00 L 500 mL 300 mL	Do not apply Funginex again if application was made at bud break.
Entomosporium leaf and berry spot	• Funginex DC • Topas 250 E or Mission 418 EC • Kumulus DF	3.00 L 500 mL 300 mL 7.50 kg	Repeat at 10–14 day intervals while disease risk persists.
Bloom			
Powdery mildew	• Nova 40 W	113 g	Apply in 1,000 L water per ha. Spray until plants are dripping. Apply no more than 340 g/ha per season.
Petal fall			
Saskatoon-juniper rust Entomosporium leaf and berry spot	• Topas 250 E or Mission 418 EC	500 mL 300 mL	Apply in at least 200 L of water per ha.
Green fruit			
Powdery mildew	• Nova 40 W	113 g	Apply in 1,000 L water per ha. Spray until plants are dripping. Apply no more than 340 g/ha per season. Repeat application in 10 days if necessary. Maximum three applications per season.
Saskatoon-juniper rust Entomosporium leaf and berry spot	• Topas 250 E or Mission 418 EC	500 mL 300 mL	Apply in at least 200 L of water per ha.

Pest	Product	Rate/ha	Comments
After Harvest			
Woolly elm aphid Woolly apple aphid	Orthene 75 % SP	3.40 kg/ha See label	<p>These aphids feed on plant roots and reduce plant vigour. After harvest dig up suspect bushes and examine the root systems for waxy white aphid colonies.</p> <p>Make one application in mid-July to mid-August, after harvest is complete.</p> <p>Application is by soil injection. Mix 0.85 g/L of water. Apply 2 L of this solution per plant. Inject in 3–5 injection points about 12 inches deep. See product label for special application instructions.</p>

TABLE 5-16. Products Used on Saskatoon Berries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval	Minimum re-entry	Maximum # of applications per season
Funginex DC	triforine	piperazine	60 days	48 hours	1
Kumulus DF	sulphur	inorganic	1 day	24 hours	
Mission 418 EC	propiconazole	triazole (DMI)	38 days	72 hours	3
Nova 40 W	myclobutanil	triazole (DMI)	14 days		3
Orthene 75 % SP	acephate	organophosphate	11 months	72 hours	1
Superior 70 Oil	mineral oil		Apply no later than ¼-inch green		1
Topas 250 E	propiconazole	triazole (DMI)	38 days	72 hours	3

Strawberry Calendars

Strawberry Calendar (Non-Bearing)

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

Products are listed according to insecticide and fungicide family groups. Use products from different family groups to help prevent pest resistance.

Diseases and Insects	Materials	Amount/ha	Comments
Early June			
Strawberry leafroller	• Malathion 25 W	4.25 kg	
One month after planting and again once or twice at 2 week intervals			
Leaf blight	• Copper 53 W	3.80 kg	To control common leaf spot, ensure good coverage of the lower leaf surface. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar, MicMac. Spray copper alone. For instructions on mixing copper sprays see <i>Use of Copper Products on Fruit Crops</i> , on page 23. Equal: Labeled for leaf scorch, leaf spot and leaf blight; the others are labeled for leaf spot only. Equal may injure plants under cold weather conditions.
Leaf scorch	• Equal 65 WP	1.75 kg	
Common leaf spot	• Supra Captan 80 WDG or Maestro 80 DF	4.25 kg 4.25 kg	
	• Topas 250 E	500 mL	
	• Pristine WG	1.30 kg	
July to mid-August			
Potato leafhopper	• Malathion 25 W	4.25 kg	Potato leafhoppers migrate long distances and can be especially problematic after nearby hay fields are mowed. Check underside of leaves and spray when nymphs are present. Repeated applications may be necessary.
Powdery mildew	• Nova 40 W	340 g	Begin applications on susceptible varieties (Annapolis, Jewel, Veestar) when red leaf speckling first appears or when conditions (warm humid weather, or frequent dews) favour development. Alternate with other fungicides.
	• Pristine WG	1.60 kg	
Common leaf spot	• Topas 250 E	500 mL	If leaf spot is present, continue fungicide applications at regular intervals, prior to wetting periods.
	• Pristine WG	1.30 kg	
Mid-August and again once or twice at 2-week intervals			
Powdery mildew	• Nova 40 W	340 g	Begin applications on susceptible varieties (Annapolis, Jewel, Veestar) when red speckling appears on the leaves, or when conditions (warm humid weather or frequent dews) favour development. Alternate with other fungicides.
	• Pristine WG	1.60 kg	
Leaf blight	• Copper 53 W	3.80 kg	To control leaf spot, ensure good coverage of the lower leaf surface. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar, MicMac. Equal: Labeled for leaf scorch, leaf spot and leaf blight; the others are labeled for leaf spot only. Equal may injure plants under cold weather conditions. Spray copper alone. For instructions on mixing copper sprays see <i>Use of Copper Products on Fruit Crops</i> , on page 23.
Leaf scorch	• Equal 65 WP	1.75 kg	
Common leaf spot	• Supra Captan 80 WDG or Maestro 80 DF	4.25 kg 4.25 kg	
	• Topas 250 E	500 mL	
	• Pristine WG	1.30 kg	

Diseases and Insects	Materials	Amount/ha	Comments
Fall			
Red stele	• Ridomil Gold 480 SL	1.00 L	This disease is sporadic and favoured by wet or compacted soil, and susceptible varieties (Table 5-21. <i>Strawberry Variety Disease Ratings</i> , on page 123). To reduce the chance of resistance, spray only where red stele has been observed or a high risk situation occurs. Ridomil Gold: Make one application in early September and a second treatment in late October but no later than October 31. Apply in sufficient water (2,500 L/ha) to ensure movement into the root zone. Aliette: Make up to four applications per season, two in spring and two in fall. Apply as a foliar spray in spring when plants start active growth. Apply at 30–60 day intervals. Make fall applications when soil conditions favour disease development (e.g. high soil moisture, cool temperatures).
	• Aliette WDG	5.60 kg	

Strawberry Calendar (Fruiting Years)

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

Products are listed according to insecticide and fungicide family groups. Use products from different family groups to help prevent pest resistance.

Diseases and Insects	Materials	Amount/ha	Comments
When new growth appears			
Red stele	Aliette WDG	5.60 kg	This disease is sporadic and favoured by wet or compacted soil, and susceptible varieties (Table 5-21. <i>Strawberry Variety Disease Ratings</i> , on page 123). To reduce the chance of resistance, spray only where red stele has been observed or a high risk situation occurs. Aliette: Make up to four applications per season, two in spring and two in fall. Apply in spring when plants start active growth. Apply at 30–60 day intervals. Do not apply within 30 days of harvest or after first bloom.
Botrytis grey mould	• Bravo 500	3.50 L	Bravo: Reduces disease inoculum and prevents infection of dying leaves. Repeat application in ten days.
When flower buds are visible in the crown			
Leaf blight	• Copper 53 W	3.80 kg	Equal: Labeled for leaf scorch, leaf spot and leaf blight; the others are labeled for leaf spot only. Equal may injure plants under cold weather conditions. To control leaf spot, ensure good coverage of the lower leaf surface. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar, MicMac. Spray copper alone. For instructions on mixing copper sprays see <i>Use of Copper Products on Fruit Crops</i> , on page 23.
Leaf scorch	• Equal 65 WP	1.75 kg	
Common leaf spot	• Supra Captan 80 WDG or Maestro 80 DF	4.25 kg 4.25 kg	
	• Topas 250 E	500 mL	
	• Pristine WG	1.30 kg	
Cyclamen mite	• Thiodan 50 WP or Thionex 50 W or Thiodan 4 EC	4.00 kg 4.00 kg 5.00 L	Apply where cyclamen mite has been a problem in the past. These tiny mites feed on developing leaves in the plant crown, causing leaf distortion and stunted growth. Thiodan, Thionex: Apply in 4,000–8,000 L of water per ha as a drench over the plant row. Agri-Mek: Apply in sufficient water, minimum 375 L/ha, to ensure thorough leaf coverage. To discourage resistance, alternate Thiodan or Thionex with Agri-Mek.
	• Agri-Mek 1.9% EC	1.00 L	

Diseases and Insects	Materials	Amount/ha	Comments
As flower buds extend from crown			
Strawberry clipper weevil	<ul style="list-style-type: none"> Furadan 480 F Ripcord 400 EC Matador 120 EC 	1.10 L 175 mL 104 mL	<p>Check edges of fields for clipped buds. See OMAFRA Factsheet, <i>Strawberry Clipper Weevil: A Major Pest of Strawberries</i>, Order No. 99-031 for monitoring details and thresholds. Apply insecticide when first injury is detected, or wait until threshold is reached. Spray again if new injury is detected seven days after the first spray.</p> <p>Furadan: Do not use later than prebloom because of toxicity to pollinating and beneficial insects. Furadan can cause extensive burning of sepals surrounding fruit on certain varieties (e.g. Annapolis, and Cavendish).</p>
First bloom			
INSECTICIDES ARE VERY TOXIC TO BEES. DO NOT SPRAY WHEN BEES ARE WORKING. SPRAY IN THE EVENING. SEE BEE POISONING ON PAGE 192.			
Tarnished plant bugs	<ul style="list-style-type: none"> Cygon 480 Ag Ripcord 400 EC Decis 5 EC Matador 120 EC Thiodan 50 WP 	2.75 L 250 mL 200 mL 104 mL 2.00 kg	<p>Check frequently during bloom and green fruit stage for small green tarnished plant bug nymphs. Shake blossom clusters and fruit trusses over a shallow dish. Watch for soft-bodied green insects that move quickly to escape. For thresholds and monitoring details, see OMAFRA Factsheet, <i>Tarnished Plant Bug</i>, Order No. 92-108 on the OMAFRA website at ontario.ca/crops.</p> <p>Ripcord, Matador or Decis: Also control clipper weevil.</p> <p>Thiodan, Ripcord, Matador or Decis: Also control spittlebug.</p> <p>Pyrethroid insecticides (Ripcord, Decis, Matador): Have been associated with outbreaks of spider mites and cyclamen mites. Avoid consecutive applications of pyrethroid insecticides.</p>
Botrytis grey mould	<ul style="list-style-type: none"> Rovral Ronilan EG Elevate 50 WDG Supra Captan 80 WDG or Maestro 80 DF Folpan 80 WDG Lance WDG Pristine WG Scala SC Switch 62.5 WG Serenade Max 	2.00 kg 2.00 kg 1.70 kg 4.25 kg 4.25 kg 2.50 kg 560 g 1.30 kg 2.00 L 975 g 3.00 kg	<p>Keep all flower parts protected with fungicide during bloom. Typically 2–3 sprays at 7–10 day intervals during bloom will give good control. Use shorter spray intervals (i.e. 5–7 days) during wet weather.</p> <p>Choose fungicides from different chemical families and use them in rotation. See Table 2-8. <i>Fungicide/Bactericide Groupings Based on Sites of Action</i>, on page 16.</p> <p>Pristine and Lance: Both contain active ingredients in the same fungicide family. Do not alternate Pristine with Lance.</p> <p>Scala and Switch: Both contain active ingredients in the same fungicide family. Do not alternate Switch with Scala.</p> <p>Serenade Max: Provides suppression, rather than control of botrytis grey mould. Expect best results from multiple applications or when used in rotation with other products.</p>
Anthraco nose fruit rot	<ul style="list-style-type: none"> Cabrio EG Pristine WG 	1.00 kg 1.30 kg	<p>Bloom is the best time to control this disease. Warm wet weather during bloom favours the development of anthracnose fruit rot.</p> <p>Pristine and Cabrio: Both contain active ingredients in the same fungicide family. Make no more than two consecutive applications of either product and then alternate with fungicides from different families. See Table 2-8. <i>Fungicide/Bactericide Groupings Based on Sites of Action</i>, on page 16.</p>

Diseases and Insects	Materials	Amount/ha	Comments
7 to 10 days after first bloom			
Tarnished plant bugs	• Ripcord 400 EC	250 mL	Check frequently for small green tarnished plant bug nymphs. Shake blossom clusters and fruit trusses over a shallow dish. Watch for soft-bodied green insects that move quickly to escape. For monitoring details and thresholds, see OMAFRA Factsheet, <i>Tarnished Plant Bug</i> , Order No. 92-108, on the OMAFRA website at ontario.ca/crops . Pyrethroid insecticides (Ripcord, Decis, Matador): Associated with outbreaks of spider mites and cyclamen mites. Avoid consecutive applications of pyrethroid insecticides.
	• Decis 5 EC	200 mL	
	• Matador 120 EC	104 mL	
	• Thiodan 50 WP	2.00 kg	
Botrytis grey mould	• Rovral	2.00 kg	Keep all flower parts protected with fungicide during bloom. Typically 2–3 sprays at 7–10 day intervals during bloom will give good control. Use shorter spray intervals (i.e. 5–7 days) during wet weather. Alternate with fungicides from different families. See Table 2-8. <i>Fungicide/Bactericide Groupings Based on Sites of Action</i> , on page 16. Pristine and Lance: Both contain active ingredients in the same fungicide family. Do not alternate Pristine with Lance. Scala and Switch: Both contain active ingredients in the same fungicide family. Do not alternate Switch with Scala. Serenade Max: Provides suppression, rather than control, of botrytis grey mould. Expect best results from multiple applications or when Serenade is used in rotation with other products.
	• Ronilan EG	2.00 kg	
	• Elevate 50 WDG	1.70 kg	
	• Supra Captan 80 WDG	4.25 kg	
	or Maestro 80 DF	4.25 kg	
	• Folpan 80 WDG	2.50 kg	
	• Lance WDG	560 g	
	• Pristine WG	1.30 kg	
	• Scala SC	2.00 L	
	• Switch 62.5 WG	975 g	
Anthracnose fruit rot	• Cabrio EG	1.00 kg	Warm wet weather during bloom favours the development of anthracnose. Pristine and Cabrio: Both contain active ingredients in the same fungicide family. Make no more than two consecutive applications of either product and then alternate with fungicides from different families. See Table 2-8. <i>Fungicide/Bactericide Groupings Based on Sites of Action</i> , on page 16.
	• Pristine WG	1.30 kg	
Preharvest			
Slugs	• Sluggo	25.00 kg	Apply 50 kg/ha if population is very high. Apply when infestation begins. Reapply as bait is consumed or at least every two weeks if slugs and snails continue to be a problem.
Two-spotted spider mite	• Pyramite or Nexter	600 g 600 g	Use high water volumes to ensure good coverage of the underside of leaves. To discourage resistance, alternate products from year to year and do not apply any product more than once each year. Apollo: Kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage. Agri-Mek: Apply in sufficient water, minimum 375 L/ha, to ensure thorough leaf coverage.
	• Kelthane 50 W	2.00 kg	
	• Apollo SC	500 mL	
	• Agri-Mek 1.9% EC	1.00 L	

Diseases and Insects	Materials	Amount/ha	Comments
Botrytis grey mould	• Rovral	2.00 kg	If sprinkler irrigation is used, water early in the day to allow plants to dry off before nightfall. Pristine and Lance: Both contain active ingredients in the same fungicide family. Do not alternate Pristine with Lance. Scala and Switch: Both contain active ingredients in the same fungicide family. Do not alternate Scala with Switch. Serenade Max: Provides suppression, rather than control, of botrytis grey mould. Expect best results from multiple applications or when Serenade is used in rotation with other products.
	• Ronilan EG	2.00 kg	
	• Elevate 50 WDG	1.70 kg	
	• Supra Captan 80 WDG or Maestro 80 DF	4.25 kg	
	• Folpan 80 WDG	4.25 kg	
		2.50 kg	
	• Lance WDG	560 g	
	• Pristine WG	1.30 kg	
	• Scala SC	2.00 L	
	• Switch 62.5 WG	975 g	
Anthracnose fruit rot	• Serenade Max	3.00 kg	Warm wet weather during bloom favours the development of anthracnose. Pristine and Cabrio: Both contain active ingredients in the same fungicide family. Make no more than two consecutive applications of either product and then alternate with fungicides from different families.
	• Cabrio EG	1.00 kg	
	• Pristine WG	1.30 kg	
Renovation (after mowing)			
Cyclamen mite	• Thiodan 50 WP or Thionex 50 W or Thiodan 4 EC	4.00 kg	These tiny mites feed on developing leaves in the plant crown, causing leaf distortion and stunted growth. High water volumes are needed to wet the new growth in the crown. Apply one of these chemicals in 5,000–8,000 L of water per ha as a drench over the plant row.
		4.00 kg	
		5.0 L	
Renovation (after mowing, to new growth)			
Two-spotted spider mite	• Pyramite or Nexter	600 g	For best results, use high water volumes to ensure good coverage of the underside of leaves. To discourage resistance, alternate products from year to year and do not apply any product more than once each year. Apollo: Kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are beginning to hatch or are mostly in the egg stage. Agri-Mek: Use postharvest only. Apply in sufficient water, minimum 375 L/ha, to ensure thorough leaf coverage.
		600 g	
	• Kelthane 50 W	2.00 kg	
	• Agri-Mek 1.9% EC	1.00 L	
Powdery mildew	• Apollo SC	500 mL	Begin applications on susceptible varieties (Annapolis, Jewel, Veestar) when disease first appears on new growth or when conditions (warm humid weather, for frequent dews) favour development. Alternate fungicides.
	• Nova 40 W	340 g	
	• Pristine WG	1.60 kg	
Mid-August and again once or twice at 2-week intervals			
Leaf blight	• Copper 53 W	3.80 kg	Equal: Labeled for leaf scorch, leaf spot and leaf blight; the others are labeled for leaf spot only. Equal may injure plants under cold weather conditions. To control leaf spot, ensure good coverage of the lower leaf surface. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar, MicMac. Spray copper alone. For instructions on mixing copper sprays see <i>Use of Copper Products on Fruit Crops</i> , on page 23.
Leaf scorch			
Common leaf spot	• Equal 65 WP	1.75 kg	
	• Supra Captan 80 WDG or Maestro 80 DF	4.25 kg	
		4.25 kg	
	• Topas 250 E	500 mL	

Diseases and Insects	Materials	Amount/ha	Comments
Fall			
Botrytis grey mould	• Bravo 500	3.50 L	Bravo helps control <i>Botrytis</i> by reducing disease inoculum. Apply late October.
Red stele	• Ridomil Gold 480 SL • Aliette WDC	1.00 L 5.60 kg	<p>This disease is sporadic and favoured by wet or compacted soil, and susceptible varieties (Table 5-21. <i>Strawberry Variety Disease Ratings</i>, on page 123). To reduce the chance of resistance, spray only where red stele has been observed or a high risk situation occurs.</p> <p>Ridomil: Do not apply later than October 31 or in the spring on established plants. Apply in sufficient water (2,500 L/ha) to ensure movement into the root zone.</p> <p>Aliette: Make up to four applications per season, two in spring and two in fall. Apply in spring when plants start active growth. Apply at 30–60 day intervals. Do not apply within 30 days of harvest (after first bloom). Make postharvest applications when soil conditions favour disease development (e.g., high soil moisture and cool soil temperatures).</p>

TABLE 5-17. Products Used on Strawberries

Use this as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume that the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Agri-Mek 1.9% EC	abamectin	avermectin	3		2
Aliette WDG	fosetyl al	phosphonate	30		4
Apollo SC	clofentezine	tetrazine	15	12 hours	1
Bravo 500	chlorothalonil	chloronitrile	30	48 hours	3
Cabrio EG	pyraclostrobin	strobilurin	1	24 hours	5
Copper 53 W	tri-basic copper sulphate	inorganic	1		
Cygon 480-Ag	dimethoate	organophosphate	7		
Decis 5 EC	deltamethrin	synthetic pyrethroid	14		2
Elevate 50 WDG	fenhexamid	hydroxyaniline	1	4 hours	4
Equal 65 WP	dodine	guanidine	7		
Folpan 80 WDG	folpet	phthalimide	1	24 hours	6
Furadan 480 F	carbofuran	carbamate	Use prebloom only	48 hours	1
Kelthane 50 W	dicofol	diphenylethane	7		1
Lance WDG	boscalid	anilide	0	4 hours	5
Maestro 80 DF	captan	phthalimide	2	48 hours	
Malathion 25 W	malathion	organophosphate	3		
Matador 120 EC	lambda-cyhalothrin	synthetic pyrethroid	7	24 hours	3
Nexter	pyridaben	pyridazinone	10	24 hours	2
Nova 40 W	myclobutanil	triazole (DMI)	3		6
Pristine WG	boscalid + pyraclostrobin	anilide carboxamide + QoI	1	24 hours	5
Pyramite	pyridaben	pyridazinone	10	24 hours	2
Ridomil Gold 480 SL	metalaxyl-M	acylamine	Use post-harvest only		2
Ripcord 400 EC	cypermethrin	pyrethroid	7		3
Ronilan EG	vinclozolin	dicarboximide	3	72 hours	4
Rovral	iprodione	dicarboximide	1	12 hours	
Scala SC	pyrimethanil	anilinopyrimidine	1	24 hours	3
Serenade Max	<i>Bacillus subtilis</i>	B.t. microbial	0		
Sluggo	ferric phosphate		0		
Supra Captan 80 WDG	captan	phthalimide	2	48 hours	
Switch 62.5 WG	cyprodinil + fludioxonil	anilinopyrimidine + phenyl pyrroles	1	12 hours	3
Thiodan 4 EC	endosulfan	chlorinated cyclodiene	7		
Thiodan 50 WP	endosulfan	chlorinated cyclodiene	7		
Thionex 50 WP	endosulfan	chlorinated cyclodiene	7		
Topas 250 E	propiconazole	triazole (DMI)	1		4

TABLE 5-18. Activity of Fungicides on Strawberry Diseases

Ratings in shaded boxes indicate that the disease is listed on the product label for control or suppression. Please see the product label or crop calendars for registered uses. Use fungicides only for diseases listed on the product label for the crop and for the disease. Additional information is provided in this table to assist the grower in choosing the best fungicide for control of diseases listed on the product label.

Fungicide Group	Product	Angular leaf spot	Anthrachnose (<i>C. acutatum</i>)	Anthrachnose (<i>C. gloeosporioides</i>)	Botrytis grey mould	Common leaf spot	Leather rot	Leaf scorch	Phomopsis leaf blight and fruit rot	Phytophthora crown rot	Powdery mildew	Red stele root rot
M1	Copper 53 W	+P	+P	+P	+P	+P	+P	+P	+P	0	+P	0
M3	Captan 80 WDG	0	++	++	++	+++	+		+ to ++	0	0	0
M3	Folpan 80 WDG	0	++	++	++	+++	+		+ to ++	0	0	0
M3	Maestro 80 DF	0	++	++	++	+++	+		+ to ++	0	0	0
M4	Bravo 500	0			++	+		+	+	0		0
M6	Equal 65 WP	0	0	0	0	++R	0	++R		0	0	0
2	Ronilan EC	0	0	0	+++R	++ to +++	0			0	0	0
2	Rovral	0	0	0	+++R	++	0		0	0	0	0
3	Nova 40 W	0	0	0	0	++	0		+++	0	+++	0
3	Topas 250 E	0	0	0	0	+++	0		+++	0		0
4	Ridomil Gold SL	0	0	0	0	0	++	0	0	++ to +++	0	++ to +++
7	Lance WDG	0			+++	+++	0	+++	0	0	++	0
7&11	Pristine WG	0	+++	+++	+++	+++	0	+++	+++	0	+++	
9	Scala SC	0	+		+++		0			0		0
9&12	Switch 62.5 WG		++		+++		0		++	0	+	
11	Cabrio EG	0	+++	+++	+ to ++	+	0	++	+++	0	+++	0
17	Elevate 50 WDG	0	0	0	+++		0	0	0	0	0	0
33	Aliette WDG	0	0	0	0	0	++	0	0	++	0	++
NC	Serenade Max				+							

0 = No control; + = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations.
Blank cell = Effect unknown. NA = Not used at the timing for this pest.
P = May be phytotoxic.
R = Pathogen resistance to the fungicide has occurred in some locations outside Ontario.

TABLE 5-19. Activity of Insecticides on Strawberry Pests

Ratings in shaded cells indicate pests are listed on the product label for control or suppression. Use products only for pests listed on the label for the crop and for the pest. Additional information is provided in this table to assist the grower in choosing the best insecticide or miticide for control of pests listed on the product label.

Group	Insecticide/miticide	Aphids	Clipper weevil	Tarnished plant bug	Root weevil larvae	Root weevil Adults	Leaf rollers	Potato leafhopper	Two-spotted spider mite	Cyclamen mite	Spittle bug	Honey bees
1A	Furadan 480 F	+	+++	+	+	++	+++	na	0	0	++	HT
1B	Cygon 480-Ag	+++	+	+++	0		+++	++	0	0	++	HT
1B	Malathion 25 W	+	+	++	0	0	++	++	0	0	++	HT
2A	Thiodan (various formulations)	+++	+	+++	0	+	++	+	0	+++	++	MT
3	Decis 5 EC	0	0	+++	0	0	+++	++	0	0	++	HT
3	Kelthane 50 W	0	0	0	0	0	0	0	++R	+	0	S
3	Ripcord 400 EC	0	+++	+++	0	++	+++	++	0	0	++	HT
3	Matador 120 EC	0	+++	+++	0	++	+++	++	0	0	++	HT
6	Agri-Mek 1.9% EC	0	0	0	0	0	0	+	+++	++		HT
10	Apollo SC	0	0	0	0	0	0	0	+++	0	0	S
21	Nexter	0	0	0	0	0	0	0	+++	++	0	HT
21	Pyramite	0	0	0	0	0	0	0	+++	++	0	HT

0 = No control; + = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations.

NA = Not used at the timing for this pest.

Blank cell = Effect unknown.

R = Pest resistance has occurred in some crops.

Bee toxicity: HT = highly toxic, MT = moderately toxic, S = relatively safe or non-toxic.

Choosing a Miticide for Strawberries

TABLE 5-20. Miticides Registered on Strawberries

	Mite species controlled	Stage of mite controlled	Comments	For use before harvest	For use after harvest
Apollo SC	Two-spotted spider mite	Eggs, very young nymphs	Should be applied when most mites are in the egg stage. This miticide works best if applied early in the season, when generations tend to be most synchronous.	✓	
Kelthane 50 W	Two-spotted spider mite	Nymphs	An older product, no longer being manufactured. Resistance to Kelthane has developed where it has been used repeatedly. This miticide works slowly; do not expect rapid knockdown of mites.	✓	✓
Agri-Mek 1.9% EC	Two-spotted spider mite, cyclamen mite	Adults, nymphs	Translaminar (locally systemic). Absorbed best by new, expanding leaves. Registered for both cyclamen mite and two-spotted spider mite.	✓	✓
Pyramite, Nexter	Two-spotted spider mite	Adults, nymphs	A contact miticide providing rapid knockdown of adults and nymphs.	✓	✓

Management Practices to Reduce Pesticide Use

Use these techniques to suppress pest populations.

Diseases & Insects	Management Practice	Comments
Between plantings		
White grubs Wireworms	Crop rotation	Avoid planting strawberries after preferred hosts such as corn, grasses, cereal species and potato. Never plant after pasture or hay crops. In the pre-plant year, consider cultivated row crops such as snap beans, white beans, cabbage, broccoli, Brussels sprouts and cauliflower or cover crops such as oil seed radish. These crops are less likely to attract or support white grubs or wireworms.
Root lesion nematode White grubs Root weevils Wireworms Annual and perennial weeds Two-spotted spider mite	Summer fallowing	Cultivate to 10 cm depth, frequently enough to kill young weeds and discourage weed growth. Avoid this practice on sloping land prone to erosion. Sow oats or spring wheat in September as a cover crop to minimize soil erosion by wind and water. Do not use cereal rye, because this encourages nematodes. For more details on preplant weed control, consult OMAFRA Publication 75, <i>Guide to Weed Control</i> . See <i>Site Preparation</i> and <i>Special Methods of Weed Control</i> sections.
Before planting		
Verticillium Red stele Leather rot Black root rot	Site selection Crop rotation	Select a site with good soil drainage. Avoid heavy, poorly drained soils. Avoid sites with a history of red stele and verticillium. Avoid growing susceptible crops before planting strawberries. Susceptible crops that favour build-up of verticillium in the soil include potato, tomato, peppers, eggplant and alfalfa.
Botrytis fruit rot Leaf scorch Leaf spot Leaf blight	Site selection	Select a planting site with good air drainage. Expose plants to direct sunlight and plant rows parallel to the direction of the prevailing winds to promote fast drying of foliage and fruit.
Root weevil Cyclamen mite	Isolation	Isolate new plantings from older infested plantings to provide a physical barrier to reduce land migration of these pests.
Red stele Verticillium	Cultivar selection	Choose varieties that have some resistance to the red stele fungus <i>Phytophthora fragariae</i> and verticillium. See Table 5-21, <i>Strawberry Variety Disease Ratings</i> , on page 123, for more information. Use only plants that have been grown under the guidelines of an accredited plant propagation program.
Harvesting years, late April to early May		
Plant bugs Spittle bug Two-spotted spider mite Botrytis fruit rot Leather rot	Weed control	Broadleaf weeds provide alternate hosts and encourage the build-up of plant bugs and two-spotted spider mites. Grassy fencerows or volunteer grass in the planting provide alternate hosts for build up of spittlebugs. Weeds keep relative humidity high and prolong leaf wetness, which encourages fruit rots.
Harvesting year, mid to late May		
Leather rot	Straw mulch	Apply straw mulch between the rows, thick enough to prevent soil from splashing onto berries.
Botrytis fruit rot Angular leaf spot Two-spotted spider mite	Fertilization	Excessive nitrogen can encourage too much foliar growth, creating a dense, humid canopy. Succulent growth resulting from abundant nitrogen is more susceptible to disease and mites.
Preharvest to harvest		
Botrytis fruit rot Leather rot Black root rot Verticillium Red stele	Irrigation scheduling	Irrigate for short periods to allow foliage and fruit to dry out before nightfall. Do not apply too much water at one time. Avoid creating puddles.

Diseases & Insects	Management Practice	Comments
Renovation		
Two-spotted spider mite Powdery mildew	Mowing	Mow off strawberry leaves to eliminate the food source for these pests and reduce the population.
Botrytis fruit rot Leather rot	Narrowing rows	Narrow the width of matted row to 30 cm to decrease plant density and encourage airflow and quick drying of the crop canopy. Incorporate plant crop residues into the soil and rototill to destroy the main source of <i>Botrytis</i> . If runnerling is too vigorous, narrow the rows again in October using a coultter.
Black root rot	Subsoiling	Subsoiling in late July or August reduces compaction and improves soil drainage.

TABLE 5-21. Strawberry Variety Disease Ratings

	Leaf Spot ^a	Leaf scorch ⁶	Powdery mildew	Botrytis rot	Verticillium	Red stele ^a	Bacterial angular leaf spot ⁴	Black root rot	Anthraxnose fruit rot
Allstar ²	MR	S	MR	MR	MR	S	HS		
Annapolis	MR	MR	S	S	MR	R	HS		
Brunswick	MR	MR	MR	MR		R		MR	
Cabot	MR	MR	R	S	S	R		MR	
Cavendish	MR	R	S	MR	MR	R	HS	MR	
Clancy							S		
Evangeline	MR	R	MR	MR	S	S		S	
Glooscap	MR	MR	MR	S	S	S	S		
Gov. Simcoe	MR	MR	HS	MR	MR	S	S		S
Harmonie	S	S	MR	MR					
Honeoye	MR	MR	MR	MR	HS	S	HS	S	
Itasca	MR	R	R			R			
Jewel ⁵	HR	MR	S	MR	S	S	HS	HS	
Kent	HS	S	MR	S	S	S	HS	HS	S
L'Amour							S		
Mesabi ⁸	R	R	MR	S		R			
Micmac	S	HS	MR	S	MR	S	S		
Mira	HS	R	R	MR	S	R	S	S	
Mohawk ⁵		MR	MR			MR			
Redcoat	MR	MR	MR	HS	S	S	S		
Sable	R	R	S	S		R	HS		
St. Pierre ⁷	MR	S	MR	R		S			S
Sapphire		MR	MR						
Seascape			HS						

HR – Highly Resistant; R – Resistant; MR – Moderately Resistant; S – Susceptible; HS – Highly Susceptible; (blank) – Unknown.

^a Race Dependent.¹ Red stele ratings from Dr. N. Nickerson and Dr. A. Jamieson, Agriculture & Agri-Food Canada, Kentville, Nova Scotia except Itasca.² Gene Galletta, USDA, Maryland, (1991).³ Marvin Pritts, Cornell, N.Y. (1991).⁴ P.D. Hildebrand, P.G. Braun et. al., Can. J. Plant Pathol. 27:16-24 (2005) and field observation.⁵ Galletta, Mass. Enns & Draper, 1995.⁶ Leaf scorch ratings according to Xue, Sutton, Dale, and Sullivan 1996, for some cultivars.⁷ Shahrokh Khanizadeh, HortScience 37(7) 2002.⁸ University of Minnesota Extension, 2002.

TABLE 5-21. Strawberry Variety Disease Ratings (cont'd)

	Leaf Spot ^a	Leaf scorch ^a	Powdery mildew	Botrytis rot	Verticillium	Red stele ^{1*}	Bacterial angular leaf spot ⁴	Black root rot	Anthraxnose fruit rot
Serenity		MR	MR						S
Sparkle	S	MR	MR	MR	S	HR	S		
Startyme	S	S	S						
Tribute	MR	MR	S	MR	R	MR			
Tristar	MR	MR	S	MR	R	MR	MR		
V151	S	S							
Veestar	S	MR	S	MR	MR	S	S		
Wendy	S	MR	MR	MR	S	MR	S		
Winona ⁶	R	MR	MR			R	HS	S	

HR – Highly Resistant; R – Resistant; MR – Moderately Resistant; S – Susceptible; HS – Highly Susceptible; (blank) – Unknown.

^{*} Race Dependent.¹ Red stele ratings from Dr.N. Nickerson and Dr. A.Jamieson, Agriculture & Agri-Food Canada, Kentville, Nova Scotia except Itasca.² Gene Galletta, USDA, Maryland, (1991).³ Marvin Pritts, Cornell, N.Y. (1991).⁴ P.D. Hildebrand, P.G. Braun et. al., Can. J. Plant.Pathol.27:16-24 (2005) and field observation.⁵ Galletta, Mass, Enns & Draper, 1995.⁶ Leaf scorch ratings according to Xue, Sutton, Dale, and Sullivan 1996, for some cultivars.⁷ Shahrokh Khanizadeh, HortScience 37(7) 2002.⁸ University of Minnesota Extension, 2002.

6. Grapes

FIGURE 6-1. Grape Growth Stages



Grape Nutrition

It is important to test the soil a year in advance of planting grape vines, or two years where pH adjustment may be necessary. Before planting is the only opportunity to thoroughly incorporate materials that do not move readily through the soil profile, but are needed to optimize vineyard productivity. These materials include organic matter, phosphorus, potassium, and lime to adjust soil pH.

Manure for Vineyards

Manure contains beneficial organic matter and a host of macro and micronutrients. The disadvantage of adding manure to vineyards is that the organic nitrogen is mineralized over time. This slow release means the vineyard receives a continuous supply of available nitrogen throughout the season. Excessive nitrogen, particularly in the second half of the growing season, can result in poor fruit colour, excessive terminal growth and delayed hardening of the woody tissue, which could make plants more susceptible to winter injury.

Observe the following guidelines to receive the benefits of manure while minimizing potential problems:

- Apply no more than 7 tonnes/ha of poultry manure (20 m³ liquid), 40 tonnes/ha of cattle manure (100 m³ liquid) and 35 tonnes/ha hog manure (65 m³ liquid). Since the nutrient content of manure varies considerably, have nutrient analysis done before application. See *Manure nitrogen*, on page 35.
- Broadcast manure and work into the soil in late fall or early spring before planting.
- Do not place manure around newly planted vines to avoid potential winter injury problems.
- Reduce the rate of nitrogen, phosphorus and potassium fertilizers applied. Table 3-12. *Average Fertilizer Replacement Values for Different Types*

of *Manure*, on page 36, shows the average composition of some manures and suggested reduction of fertilizer when manure is used.

- For more information about food safety and the environmental impacts of manure application see *Manure nitrogen*, on page 35 and *Use manure responsibly*, on page 35.

pH Requirements

The pH of a soil is a measure of its acidity and affects nutrient availability and crop performance. Soil pH should be adjusted before planting to 6.5 on sandy soils and 6.0 on clay soils.

In established vineyards sample soil in the vine row every three years to ensure the pH is satisfactory. If pH is low or acidic, apply lime in the fall to the sod cover or before spring cultivation. The results will not show immediately because lime reacts slowly in the soil.

- Apply lime to established vineyards when the pH drops below 5.1 on clay loam soils and drops below 5.6 on sandy soils. Lime raises the soil pH, reduces its acidity and also supplies calcium.
- For details regarding rates and suggested types of lime to use, refer to *Soil pH and Liming*, on page 31.

Petiole Analysis for Grapes

In established plantings, the best method to determine the nutrient status of the vines is petiole analysis. In conjunction with soil analysis, petiole analysis ensures good information for determining fertilizer and lime needs. For more information on these tests consult *Plant tissue analysis*, on page 29.

Nutrient uptake is affected by many vineyard conditions. Consequently, nutrient levels vary slightly from year to year, depending on the season. To obtain optimum growth and fruit quality, all nutrients

TABLE 6-1. Nutrient Sufficiency Range of Grape Petioles (Taken in September from Mature Vines)

Variety	N	P	K*	Ca	Mg	Fe	B	Zn	Mn
	%					ppm			
Vinifera	0.8–1.4	0.15–0.40	1.2–2.3	1.0–3.0	0.6–1.5	15–100	20–60	15–100	20–200
Fredonia	0.6–1.2	0.15–0.40	0.8–1.8	1.0–3.0	0.6–1.5	15–100	20–60	15–100	20–200
Other	0.7–1.3	0.15–0.40	1.0–2.0	1.0–3.0	0.6–1.5	15–100	20–60	15–100	20–200

* Potassium levels will be higher with grapes grown on sandy loam soils.

TABLE 6-2. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
3 sprays spaced 10 days apart beginning in mid July	Magnesium sulfate (Epsom salts)	20 kg/1,000 L water	Wet plant to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

must be present at concentrations in the sufficiency range in the petioles.

For leaf analysis to be most effective, sample the same vines each year and make adjustments to the fertilizer program on the basis of this petiole analysis. Consult Table 6-1. *Nutrient Sufficiency Range of Grape Petioles*, on page 126.

Fertilizer requirements are adjusted to soil management practices, vine age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered to determine fertilizer requirements. Further information is available in OMAFRA Factsheet, *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

Fertilizer for Grapes

The best time to effectively incorporate nutrients such as potassium, phosphorus, boron and lime into the soil is prior to planting the vineyard. Nutrient levels in the topsoil adequate for vineyard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. Table 6-3, *Phosphorus and Potassium Soil Requirements Before Planting Grapes*, on page 128, provides fertilizer rates prior to planting. Along with incorporation of organic matter such as manure, these fertility levels will sustain the vineyard through the juvenile years.

- On coarse-textured, infertile soils use a starter solution at planting time of 10-52-10 or 20-20-20.
- High nitrogen levels can result in excessive growth and incomplete vine hardening. Use cover crops to reduce late season nitrogen levels in cultivated vineyards, especially in new plantings. Cover crops such as Italian ryegrass, should be sown about July 1 to take up much of the available nitrogen in the soil.

Nitrogen (N)

- Use petiole analysis to determine nitrogen requirements of grapes. Without such information, 34 kg of nitrogen per ha is usually sufficient for most cultivars.
- Broadcast before the first cultivation or apply as early as possible in the spring in sod vineyards.
- Do not apply urea (46-0-0) to sod vineyards since some nitrogen is lost by volatilization.
- Nitrogen application can be reduced or eliminated if manure is used or growth has been excessive.
- Based on vine performance and petiole analysis, consider foliar applications of nitrogen in some years.
- If severe winter temperatures cause fruit bud damage, it may be necessary to split applications. Apply the first application in mid-April and the second application, if necessary, after bloom in late May.
- During dry springs, irrigate if necessary to move the fertilizer into the rooting zone of the soil just before first bloom or immediately after petal fall.

Phosphorus (P)

Grapes do not require high levels of soil phosphorus. With a few exceptions, the level of phosphorus in Ontario soils is adequate. Phosphorus is necessary for sod or cover crop maintenance. Use a soil test to determine if phosphorus is required. If a soil test indicates the need, apply phosphorus before you plant a vineyard when it can be thoroughly incorporated in the soil. Phosphorus soil test values between 12–20 ppm are considered adequate for vineyard establishment and production.

Potassium (K)

Grapes require larger amounts of potassium than tree fruits. Use a soil test to determine the amount of potassium required. Excess potassium can lead to deficiency of magnesium (Mg); avoid unnecessary potassium applications.

TABLE 6-3. Phosphorus and Potassium Soil Requirements Before Planting Grapes

Soil phosphorus		Soil potassium	
New plantings of grapes*		New plantings of grapes*	
Soil test (ppm P)	Phosphate (P ₂ O ₅) req'd kg/ha	Soil test (ppm K)	Potash (K ₂ O) req'd kg/ha
0–3	80 HR	0–15	270 HR
4–5	60 HR	16–30	270 HR
6–7	50 HR	31–45	270 HR
8–9	40 MR	46–60	270 HR
10–12	20 MR	61–80	270 HR
13–15	0 LR	81–100	270 HR
16–20	0 LR	101–120	270 HR
21–25	0 RR	121–150	270 MR
26–30	0 RR	151–180	270 MR
31–40	0 RR	181–210	270 MR
41–50	0 RR	211–250	270 LR
51–60	0 RR	250 +	270 LR
61–80	0 NR		
80 +	0 NR		

* Apply only every second year. For established grapes, plant analysis is used to estimate requirements of N, P and K. HR, MR, LR, RR, and NR denote, respectively, high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

- Prior to establishment, incorporate potassium according to Table 6-3. *Phosphorus and Potassium Soil Requirements Before Planting Grapes*, on this page.
- In established cultivated vineyards, broadcast potassium before the first cultivation in the spring.
- In established sod vineyards, and vineyards on clay soils, apply potassium in a band to reduce potassium fixation and increase its availability to the vines. Potash can injure roots and trunks if applied too closely to the trunk.

Foliar application of potassium for grapes

In dry growing seasons, potassium is not readily available to the plant. Where a potassium deficiency exists, foliar applications of potassium may help.

Foliar potassium applied at veraison may improve fruit yield and quality.

Magnesium (Mg)

Magnesium soil test values between 100–250 ppm are considered adequate for grapes. Dolomitic limestone can be used on acidic soils to raise the soil pH and to supply magnesium. Magnesium deficiency has become more evident in vineyards, particularly when high rates of potash are used.

Magnesium deficiency can lead to premature fruit drop at harvest. Because magnesium is a part of the chlorophyll molecule, magnesium deficient vines have older leaves that are pale in colour. Petiole analysis is the best way to evaluate magnesium levels.

Foliar sprays of magnesium correct this deficiency for the current year only. For long-term corrections, apply magnesium to the soil. The response will not likely be immediate. On some soil types a single, early-spring application of soil-applied magnesium has not worked well. A second or third application the next spring may be required before the magnesium level in the plant improves.

Foliar sprays are recommended for the first two years, in addition to soil applications. See Table 6-2. *Magnesium Foliar Sprays*, on page 127.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate. It is best to apply magnesium sulfate separately or try it on a few plants first. Check manufacturer's label in regard to mixtures of magnesium chelates¹ with pesticides.

Calcium (Ca)¹

Calcium deficiency has been associated with stem and bunch breakdown of Canada Muscat and Himrod grapes. If applied too close to harvest, some formulations of calcium chloride (CaCl₂) result in poor fruit finish.

- Use CaCl₂ (77% flakes) at 4 kg/1,000 L of water from early July to mid-August. Apply three sprays, 10–12 days apart. The more calcium applied, the better the control, but do not concentrate sprays as foliage may burn as a result.
- Do not apply calcium formulations that contain nitrogen after the end of July or fruit quality may suffer.

¹ Use chelates recommended for foliar sprays.

- Apply calcium in adequate water volume to wet the entire vine. Calcium sprays must contact the fruit for uptake to be effective.

For all formulations, consult label directions for concentrations to use and compatibility with pesticides. The product used is not as important as the total amount of actual or elemental calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results up to 12 kg/ha of actual calcium is often required in a total of four or more sprays. Calcium sprays may damage foliage and fruit if applied during low temperatures and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

Micronutrients for Grapes

Deficiencies of micronutrients or trace elements are not widespread in Ontario plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess, rather than from deficiencies. For this reason, do not apply micronutrients unless petiole analysis confirms a deficiency. Only apply the nutrient that is deficient and in sufficient quantities to correct the problem. Additional information can be found in *Micronutrients*, on page 40.

Warning: Do not concentrate nutrient sprays.

Do not spray at temperatures above 25°C.

Grape Calendar

Read the label and follow all safety precautions. Some grape varieties are sensitive to Sulphur, Thiodan, Copper, Dikar, Dikar plus Zolone, or other products. See Table 6-5, *Relative Disease Susceptibilities*, on page 140, for specific information.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 6-4, *Products Used on Grapes*, on page 137.

Resistance management

To delay development of resistance to fungicides, miticides and insecticides, follow resistance management guidelines outlined in *Pest Resistance to Insecticides, Fungicides, Miticides*, on page 13.

In addition, take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce label rates.
- Do not use Nova, Sovran, Lance or Flint as eradicants when powdery mildew is already a severe problem.
- Use sufficient water to provide thorough coverage.

Preharvest intervals

Contact the processors and wineries directly in regard to their preharvest interval policy. Preharvest intervals listed in Table 6-4, *Products Used on Grapes*, on page 137, are stated on product labels and are generally based on acceptable residues on fresh produce. In some cases, regulations on residues in finished products (e.g. wine) are much more stringent. Many processors require longer preharvest intervals than stated on product labels. Some processors and wineries also have special restrictions for certain pest control products regarding number of applications or application after a certain crop stage. Consult the contract purchaser of your grapes for more details.

Spray water volumes

Sufficient water volumes are necessary to provide complete coverage with grape fungicides, miticides and insecticides. Increased water volumes are necessary as the season progresses and canopies grow. Canopy management through hedging, leaf-pulling and shoot thinning, as well as proper sprayer calibration, are critical to ensure proper spray coverage. Although water is only the carrier for pesticides, sufficient coverage and efficacy is not possible if water volumes are severely reduced. Some types of sprayers are able to provide sufficient coverage with less water than other sprayers. Consult with equipment dealers and professional crop consultants about the amount of water needed to ensure adequate coverage. Read and follow water volume requirements on all product labels.

Diseases and Insects	Materials	Amount/ha	Comments
First leaf, 1.25–5.0 cm shoot length			
Phomopsis cane and leaf spot	• Supra Captan 80 WDC or Maestro 80 DF	see label 2.00 kg	Begin spraying susceptible varieties early where there has been a history of phomopsis and conditions are wet. Apply in sufficient water volume to ensure complete coverage.
	• Folpan 80 WDC	1.25 kg	
3–5 leaves unfolded, 10–15 cm shoot length			
Phomopsis cane and leaf spot	• Supra Captan 80 WDC or Maestro 80 DF	see label 2.00 kg	Begin spraying susceptible varieties early where there is a history of phomopsis and conditions are wet. Apply in sufficient water volume to ensure complete coverage.
	• Folpan 80 WDC	1.25 kg	
Black rot	• Nova 40 W	200 g	
	• Ferbam 76 WDC	see label	

Diseases and Insects	Materials	Amount/ha	Comments
Powdery mildew	<ul style="list-style-type: none"> • Nova 40 W • Dikar • Microscopic Sulphur or Kumulus DF • MilStop • Serenade Max 	200 g 5.50 kg see label 12.60 kg 2.80 kg 3.00 kg	<p>This spray is important to protect expanding leaves and developing fruit clusters from infections. Intervals between sprays should be about 7–10 days. Under rainy conditions, spray at seven-day intervals.</p> <p>Nova: Maximum three applications per season.</p> <p>MilStop: Pre-bloom rate is based on 500 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with other products or use pH adjusters or oil with MilStop. MilStop works best as an eradicant.</p> <p>Serenade Max: Provides suppression of powdery mildew.</p>
Shoot length, 20–25 cm			
Phomopsis cane and leaf spot	<ul style="list-style-type: none"> • Supra Captan 80 WDG or Maestro 80 DF • Folpan 80 WDG 	see label 2.00 kg 1.25 kg	<p>Begin spraying susceptible varieties early where there is a history of phomopsis and when conditions are wet. Apply in sufficient water volume to ensure complete coverage.</p>
Black rot	<ul style="list-style-type: none"> • Nova 40 W • Polyram DF • Sovran • Flint 50 WG • Ferbam 76 WDG 	200 g see label 240 g 140 g see label	<p>Sovran and Flint: Belong to the same chemical group. Apply no more than two consecutive sprays of either product and no more than four sprays of either product per season. If applying two consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval.</p> <p>Sovran: Is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops.</p> <p>Flint: Do not apply to Concord grapes or crop injury may occur.</p>
Downy mildew	<ul style="list-style-type: none"> • Ridomil Gold MZ 68 WP • Dikar • Polyram DF • Maestro 80 DF or Supra Captan 80 WDG • Folpan 80 WDG • Gavel 75 DF • Sovran 	2.50 kg 5.50 kg see label 2.00 kg see label 1.25 kg 2.25 kg 300 g	<p>If bloom is delayed or wet weather is expected, spray again.</p> <p>Ridomil Gold MZ: Maximum one prebloom application.</p> <p>Sovran: Apply no more than two consecutive sprays of Sovran and no more than four Sovran sprays per season. If applying two consecutive sprays of Sovran, use a 14-day interval. If alternating Sovran with another fungicide, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops.</p>
Powdery mildew	<ul style="list-style-type: none"> • Nova 40 W • Dikar • Microscopic Sulphur or Kumulus DF • Sovran • Lance WDG • Flint 50 WG • MilStop • Serenade Max 	200 g 5.50 kg see label 12.60 kg 300 g 315 g 140 g 2.80 kg 3.00 kg	<p>This spray is important to protect expanding leaves and developing fruit clusters from infections. Spray at least every 14 days. Under rainy conditions, intervals may need to be shortened.</p> <p>Sovran and Flint: Belong to the same chemical family. Apply no more than two consecutive sprays of either product and no more than four sprays of either product per season. If applying two consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval.</p> <p>Sovran: Is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops.</p> <p>Flint: Do not apply to Concord grapes or crop injury may occur.</p> <p>Nova: Maximum three applications per season.</p> <p>Lance: Maximum two applications per season.</p> <p>MilStop: Prebloom rate is based on 500 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with other products or use pH adjusters or oil with MilStop. MilStop works best as an eradicant.</p> <p>Serenade Max: Provides suppression of powdery mildew.</p>

Diseases and Insects	Materials	Amount/ha	Comments
Immediate prebloom (flower cluster with floret separation)			
Grape berry moth (1st generation)	<ul style="list-style-type: none"> Isomate GBM Plus Pounce Imidan 50 WP Diazinon 50 W Sevin XLR Guthion 50 WSB or Sniper Success 480 SC 	500 dispensers 360 mL 1.90 kg 3.375 kg 5.25 L see label see label 182 mL	<p>Where there is a history of early season grape berry moth injury, apply an insecticide for first generation. Apply in high water volumes to ensure complete coverage.</p> <p>Mating Disruption: Vineyard block treated must be larger than 2 ha.</p> <p>Isomate GBM Plus: Apply in late April or early May prior to flight and mating of grape berry moth (GBM) adults.</p> <p>Isomate GBM Plus: Lasts for approximately 150 days.</p> <p>Isomate GBM Plus: This pheromone is specific for GBM and will not control other pests. Routine insect monitoring and sampling throughout the season is necessary to ensure that GBM is adequately controlled and to determine if special sprays are necessary for sporadic pests. For more information see, OMAFRA Factsheets, <i>Mating Disruption for Management of Insect Pests</i>, Order No. 03-079 and <i>Insect and Disease Identification Guide for Grapes</i>, Order No. 03-039.</p> <p>Success 480: Provides suppression of GBM.</p>
Japanese beetle	<ul style="list-style-type: none"> Imidan 50 WP 	1.90 kg	<p>Japanese beetle is a sporadic pest which feeds on over 300 plant species. Monitoring is essential to determine beetle presence and extent of feeding damage. Damage may be very localized and spot applications of insecticide may be adequate for control. Re-infestation may occur after treatment.</p>
Leafhoppers	<ul style="list-style-type: none"> Assail 70 WP Surround WP Pounce Diazinon 50 W Sevin XLR Guthion 50 WSB or Sniper 	80 g 50.00 kg 175 mL 3.375 kg 5.25 L see label see label	<p>Grape leafhopper (GLH), potato leafhopper (PLH) and three banded leafhopper (TBLH) are the three main species of leafhoppers that feed on grapes. GLH causes pale white stippling along the veins. TBLH damage is similar to GLH. In some vineyards, Guthion no longer gives control of GLH.</p> <p>PLH feeding causes the leaves to yellow along the margins. Leaves cup upwards and later develop marginal necrosis. All products listed provide control of PLH.</p> <p>Leafhoppers are active throughout most of the growing season.</p> <p>Surround WP: May delay brix accumulation. Closely monitor harvest parameters to determine optimal time to harvest. Use full rate of Surround for the first two applications to establish the protectant layer. Use reduced rate (see label) to maintain even coverage thereafter. Applications after veraison will adhere better to grape berries. For table grapes where a residual white film is undesirable, do not apply Surround post-bloom.</p>
Black rot	<ul style="list-style-type: none"> Nova 40 W Ferbam 76 WDG Sovran Polyram DF Flint 50 WG 	200 g see label 240 g see label 140 g	<p>This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to black rot from bloom to pea-sized berry stage (4–6 weeks post-bloom).</p> <p>Sovran and Flint: Belong to the same chemical family. Maximum two consecutive applications of either product and maximum four sprays of either product per season. If applying two consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval.</p> <p>Sovran: Is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops.</p> <p>Flint: Do not apply to Concord grapes or crop injury may occur.</p>

Diseases and Insects	Materials	Amount/ha	Comments
Downy mildew	<ul style="list-style-type: none"> • Ridomil Gold MZ 68 WP • Dikar • Polyram DF • Maestro 80 DF • or Supra Captan 80 WDG • Folpan 80 WDG • Gavel 75 DF • Sovran 	2.50 kg 5.50 kg see label 2.00 kg see label 1.25 kg 2.25 kg 300 g	<p>If bloom is delayed or wet weather is expected, repeat the application. This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to downy mildew from bloom until the berries are pea sized. Intervals between sprays should be 7–10 days. Under rainy conditions use the shorter interval.</p> <p>Sovran: Maximum two consecutive applications and maximum four Sovran sprays per season. If applying two consecutive sprays of Sovran, use a 14-day interval. If alternating Sovran with another fungicide, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops.</p> <p>Ridomil Gold MZ: Maximum one pre-bloom application per season.</p>
Powdery mildew	<ul style="list-style-type: none"> • Nova 40 W • Dikar • Microscopic Sulphur • or Kumulus DF • Sovran • Lance WDG • Flint 50 WG • MilStop • Serenade Max 	200 g 5.50 kg see label 12.60 kg 300 g 315 g 140 g 2.80 kg 3.00 kg	<p>This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to powdery mildew from bloom until the berries are pea-sized. Intervals between sprays should be 7–10 days. Under rainy conditions use the shorter interval.</p> <p>Sovran and Flint: Belong to the same chemical family. Maximum two consecutive sprays of either product and no more than four sprays of either product per season. If applying two consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval.</p> <p>Sovran: Is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops.</p> <p>Flint: Do not apply to Concord grapes or crop injury may occur.</p> <p>Lance: Maximum two applications per season.</p> <p>Nova: Maximum three applications per season.</p> <p>MilStop: Prebloom rate is based on 500 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with other products or use pH adjusters or oil with MilStop. MilStop works best as an eradicant.</p> <p>Serenade Max: Provides suppression of powdery mildew.</p>
DO NOT APPLY INSECTICIDES WHILE GRAPES ARE IN BLOOM. SEE BEE POISONING ON PAGE 192.			
Immediate post-bloom to early fruit set			
Leafhoppers	Use one of the materials listed for leafhoppers at Immediate prebloom (flower cluster with floret separation) if monitoring shows the need for leafhopper control.		See comments on leafhoppers at Immediate prebloom (flower cluster with floret separation) .
Grape phylloxera (leaf form)	<ul style="list-style-type: none"> • Thiodan 50 WP • or Thionex 50 W 	see label see label	Only French hybrid and vinifera varieties are susceptible to this pest. Thiodan/Thionex can cause phytotoxicity (leaf burning) on some French hybrid varieties, notably Baco Noir.
Japanese beetle	<ul style="list-style-type: none"> • Imidan 50 WP 	2.50 kg	Japanese beetle is a sporadic pest which feeds on over 300 plant species. Monitoring is essential to determine beetle presence and extent of feeding damage. Damage may be very localized and spot applications of insecticide may be adequate for control. Re-infestation may occur after treatment.

Diseases and Insects	Materials	Amount/ha	Comments
Downy mildew	<ul style="list-style-type: none"> • Dikar • Polyram DF • Maestro 80 DF or Supra Captan 80 WDG • Folpan 80 WDG • Gavel 75 DF • Sovran • Ridomil Gold MZ 68 WP 	5.50 kg see label 2.00 kg see label 1.25 kg 2.25 kg 300 g 2.50 kg	<p>Spray all varieties for downy mildew at this time. Intervals between sprays should be 7–10 days. Under rainy conditions use the shorter interval.</p> <p>Sovran: Maximum two consecutive sprays and no more than four Sovran sprays per season. If applying two consecutive sprays of Sovran, use a 14-day interval. If alternating Sovran with another fungicide, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. Do not apply Sovran once sporulating lesions are visible.</p> <p>Ridomil Gold MZ: Maximum one post-bloom application per season.</p>
Black rot	<ul style="list-style-type: none"> • Nova 40 W • Folpan 80 WDG • Supra Captan 80 WDG or Maestro 80 DF • Polyram DF • Sovran • Flint 50 WG 	200 g 1.25 kg see label 2.00 kg see label 240 g 140 g	<p>Sovran and Flint: Belong to the same chemical family. Maximum two consecutive sprays of either product and no more than four sprays of either product per season. If applying two consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval.</p> <p>Sovran: Is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops.</p> <p>Flint: Do not apply to Concord grapes or crop injury may occur.</p>
Powdery mildew	<ul style="list-style-type: none"> • Nova 40 W • Microscopic Sulphur or Kumulus DF • Dikar • Sovran • Lance WDG • Flint 50 WG • MilStop • Serenade Max 	200 g see label 12.60 kg 5.50 kg 300 g 315 g 140 g 5.60 kg 3.00 kg	<p>Fruit clusters are highly susceptible to powdery mildew from bloom to pea-sized berry stage. Young developing fruit and leaves are very susceptible at this stage. It is important to maintain protectant coverage. Intervals between sprays should be 7–10 days. Under rainy conditions use the shorter interval.</p> <p>Nova: Maximum three applications per season.</p> <p>Sovran and Flint: Belong to the same chemical family. Apply no more than two consecutive sprays of either product and no more than four sprays of either product per season. If applying two consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval.</p> <p>Sovran: Is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops.</p> <p>Flint: Do not apply to Concord grapes or crop injury may occur.</p> <p>Lance: Do not use more than two times per season. Do not use Sovran, Flint or Lance once sporulating lesions are visible.</p> <p>MilStop: Post-bloom rate is based on 1,000 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with other products or use pH adjusters or oil with MilStop. MilStop works best as an eradicant.</p> <p>Serenade Max: Provides suppression of powdery mildew.</p>
Botrytis bunch rot	See comments for botrytis bunch rot control under Berry touch to cluster closure . In varieties prone to botrytis bunch rot, and if the bloom/post-bloom period is wet, an immediate post-bloom spray may provide control of latent infections.		

Diseases and Insects	Materials	Amount/ha	Comments
Berries pea-sized			
Grape berry moth (2nd generation)	<ul style="list-style-type: none"> Pounce Imidan 50 WP Diazinon 50 W Sevin XLR Guthion 50 WSB or Sniper Success 480 SC 	360 mL 3.10 kg 3.375 kg 5.25 L see label see label 182 mL	Where mating disruption (MD) for GBM is in place and is working well based on monitoring, an insecticide is not needed at this time. Where berry moth is a regular problem, use one of these products. Apply sprays in high water volumes to ensure complete coverage. Success 480: Provides suppression of GBM.
Phylloxera (leaf form)	Repeat as in Immediate postbloom to early fruit set .		
Powdery mildew	<ul style="list-style-type: none"> Nova 40 W Dikar Microscopic Sulphur or Kumulus DF Lance WDC Flint 50 WG Sovran MilStop Serenade Max 	200 g 5.50 kg see label 12.60 kg 315 g 140 g 300 g 5.60 kg 3.00 kg	Sovran and Flint: Belong to the same chemical family. Maximum two consecutive sprays of either product and no more than four sprays of either product per season. If applying two consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval. Sovran: Is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. Lance: Do not use more than two times per season. Flint: Do not apply to Concord grapes or crop injury may occur. Do not use Sovran, Flint or Lance once sporulating lesions are visible. MilStop: Post-bloom rate is based on 1,000 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with other products or use pH adjusters or oil with MilStop. MilStop works best as an eradicant. Serenade Max: Provides suppression of powdery mildew.
Downy mildew	<ul style="list-style-type: none"> Dikar Folpan 80 WDC Supra Captan 80 WDC or Maestro 80 DF Polyram DF Gavel 75 DF 	5.50 kg 1.25 kg see label 2.00 kg see label 2.25 kg	
Black rot	<ul style="list-style-type: none"> Nova 40 W Ferbam 76 WDC Folpan 80 WDC Supra Captan 80 WDC or Maestro 80 DF Polyram DF Flint 50 WG Sovran 	200 g see label 1.25 kg see label 2.00 kg see label 140 g 240 g	For effective control, apply in high water volumes to ensure coverage. Sovran and Flint: Belong to the same chemical family. Apply no more than two consecutive sprays of either product and no more than four sprays of either product per season. If applying two consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval. Sovran: Is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. Flint: Do not apply to Concord grapes or crop injury may occur.
Berry touch to cluster closure			
Powdery mildew	<ul style="list-style-type: none"> Nova 40 W Microscopic Sulphur or Kumulus DF Dikar Lance WDC MilStop Serenade Max 	200 g see label 12.60 kg 5.50 kg 315 g 5.60 kg 3.00 kg	Lance: Maximum two applications per season. Check product labels and Table 6-4. <i>Products Used on Grapes</i> , on page 137, for days to harvest intervals. MilStop: Post-bloom rate is based on 1,000 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with other products or use pH adjusters or oil with MilStop. MilStop works best as an eradicant. Serenade Max: Provides suppression of powdery mildew.

Diseases and Insects	Materials	Amount/ha	Comments
Downy mildew	<ul style="list-style-type: none"> Dikar Folpan 80 WDG Supra Captan 80 WDG or Maestro 80 DF Polyram DF Gavel 75 DF 	5.50 kg 1.25 kg see label 2.00 kg see label 2.25 kg	Check product labels and Table 6-4, <i>Products Used On Grapes</i> , on page 137, for days to harvest intervals.
Botrytis bunch rot	<ul style="list-style-type: none"> Rovral Vangard 75 WG Elevate 50 WDG Scala SC 	1.50 kg 750 g 1.12 kg 2.00 L	Direct this spray at the fruiting zone. Many of the vinifera and vinifera hybrid varieties with tight clusters are susceptible to botrytis bunch rot, e.g. Gamay Noir, Pinot Noir, Pinot Gris, Riesling, Chardonnay, Chancellor and Seyval Blanc. These susceptible varieties may require more than one application during the bunch closure period. Elevate: Use Agral 90 at 200 mL/1,000 L of water (0.02% v/v) with the product in the tank. Do not apply Elevate if rainfall is expected within six hours after application.
Two-spotted spider mite European red mite	<ul style="list-style-type: none"> Pyramite or Nexter Envirdor 240 SC Acramite 50 WS Kelthane 50 W 	300 g 300 g 0.75 L see label 2.00 kg	A miticide may be required if significant bronzing of mid shoot leaves occurs as a result of mite infestation. Stressed vines will show injury earlier than healthy vines. Monitor 7–10 days after application to evaluate mite control. Use any miticide only once per season and alternate. One miticide per year and alternating products is an effective resistance management strategy. Pyramite/Nexter: Is most effective against active nymphal stages, not adults. Acramite: Requires different rates for different pest mite species. Envirdor: Is effective on mite eggs, nymphs and adult females.
Beginning of ripening (veraison period)			
Grape berry moth (about mid–late Aug.)	<ul style="list-style-type: none"> Pounce Imidan 50 WP Diazinon 50 W Guthion 50 WSB or Sniper Success 480 SC 	360 mL 3.10 kg 3.375 kg see label see label 182 mL	Where mating disruption (MD) for GBM is in place and is working well based on monitoring, an insecticide may not be needed at this time. Where berry moth is a regular problem, use one of these products. Apply sprays in high water volumes to ensure complete coverage. Check the interval to harvest. A spray may be needed on late varieties to control the brood which emerges in late August. Border sprays of conventional insecticides may be very effective. Success 480: Provides suppression of GBM.
Powdery mildew	Use one of the materials listed under Berry touch to cluster closure . Check for interval to harvest.		Vinifera and French hybrid varieties are more susceptible and may require extra sprays. Check product labels and Table 6-4, <i>Products Used On Grapes</i> , on page 137, for days to harvest intervals.
Downy mildew	Use one of the materials listed under Berry touch to cluster closure .		Check product labels and Table 6-4, <i>Products Used On Grapes</i> , on page 137, for days to harvest intervals.
Botrytis bunch rot	<ul style="list-style-type: none"> Vangard 75 WG Elevate 50 WDG Scala SC 	750 g 1.12 kg 2.00 L	When late summer or fall weather conditions are wet and humid, protection against <i>Botrytis</i> is necessary during the ripening or veraison period. This is especially important for vineyards designated for late harvest or ice wine. For further information on product choice and use, see comments under Berry touch to cluster closure .
Slugs and snails	<ul style="list-style-type: none"> Sluggo 	25.00 kg	Apply higher rate of 50 kg/ha if population is very high. Apply when infestation begins. Reapply as the bait is consumed or at least every 2 weeks if slugs and snails continue to be a problem.

Diseases and Insects	Materials	Amount/ha	Comments
Special sprays (when monitoring indicates the need)			
Multicoloured Asian lady beetle	<ul style="list-style-type: none"> Ripcord 400 EC Malathion 500 E 	150 mL 1.80 L	Lady beetles are not a problem unless it is very close to harvest. Begin monitoring around mid-August and continue for each cultivar until harvested. Early presence of lady beetles is not an immediate concern, because they can arrive and leave an area rapidly. Discuss beetle thresholds and product restrictions with the proposed purchaser of grapes before taking action. Continue to monitor after treatment; re-infestation may occur before harvest. Other species of lady beetles besides multicoloured Asian lady beetle, <i>Harmonia axyridis</i> , may appear in vineyards but generally do not require control. Ripcord: Cannot be used on juice grapes destined for export to the US.

Preharvest intervals

Contact the processors and wineries directly in regard to their preharvest interval policy. Preharvest intervals listed in Table 6-4, *Products Used on Grapes*, on pages 137–138, are stated on product labels and are generally based on acceptable residues on fresh produce. In some cases, regulations on residues in finished products (e.g. wine) are much more stringent. Many processors require longer preharvest intervals than stated on product labels. Some processors and wineries also have special restrictions for certain pest control products regarding number of applications or application after a certain crop stage. Consult the contract purchaser of your grapes for more details.

TABLE 6-4. Products Used on Grapes

Use this table as a guide, but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation beneficial insects.

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Acramite 50 WS	bifenazate	carbazate	14	12 hours except 2 days for hand labour	1
Assail 70 WP	acetamiprid	neonicotinoid	7	12 hours	2
Diazinon 50 W	diazinon	organophosphate	16		
Dikar	mancozeb + dinocep	dithiocarbamate	30	48 hours	
Elevate 50 WDG	fenhexamid	hydroxylaniline	7	4 hours	3
Envidor 240 SC	spirodiclofen	tetronic acid derivative	14	12 hours	1
Ferbam 76 WDG	ferbam	dithiocarbamate	7		
Flint 50 WG	trifloxystrobin	strobilurin	14	5 days	4
Folpan 80 WDG	folpet	phthalimide	1		2
Gavel 75 DF	zoxamide + mancozeb	benzamide + dithiocarbamate	66	48 hours	6
Guthion 50 WSB	azinphosmethyl	organophosphate	28	28 days	2
Imidan 50 WP	phosmet	organophosphate	7		3

* Check with processor and winery for wine grapes.

** 21 days for wine grapes. One day for table grapes.

TABLE 6-4. Products Used on Grapes (cont'd)

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Kelthane 50 W	dicofol	diphenylethane	7		1
Kumulus DF	sulphur	inorganic	21**		
Lance WDG	boscalid	anilide carboximide	14	4 hours	5
Maestro 80 DF	captan	phthalimide	7	72 hours	
Malathion 500 E	malathion	organophosphate	3	24 hours	1
Microscopic Sulphur	sulphur	inorganic	21**	24 hours	
MilStop	potassium bicarbonate	not classified	0	4 hours	10
Nexter	pyridaben	pyridazinone	25	24 hours	1
Nova 40 W	myclobutanil	triazole (DMI)	14		5
Polyram DF	metiram	dithiocarbamate	45		3
Pounce	permethrin	pyrethroid	21		
Pyramite	pyridaben	pyridazinone	25	24 hours	1
Ridomil Gold MZ 68 WP	metalaxyl + mancozeb	acylamine + dithiocarbamate	66	12 hours	1 prebloom and 1 postbloom
Ripcord 400 EC	cypermethrin	pyrethroid	7		2
Rovral	iprodione	dicarboximide	7*	12 hours	2
Scala SC	pyrimethanil	anilinopyrimidine	7	24 hours for hand labour	3
Serenade Max	<i>Bacillus subtilis</i>	microbial	0		
Sevin XLR	carbaryl	carbamate	5*		
Sluggo	ferric phosphate		0		
Sniper	azinphosmethyl	organophosphate	28	28 days	2
Sovran	kresoxim-methyl	strobilurin	14	48 hours	4
Success 480 SC	spinosad	naturalyte	7	7 days for hand labour	3
Supra Captan 80 WDG	captan	phthalimide	7	72 hours	
Surround WP	kaolin clay		0		
Thiodan 50 WP	endosulfan	chlorinated cyclodiene	30		
Thionex 50 W	endosulfan	chlorinated cyclodiene	30		
Vanguard 75 WG	cyprodinil	anilinopyrimidine	7	48 hours	2

* Check with processor and winery for wine grapes.

** 21 days for wine grapes. One day for table grapes.

Notes on Grape Pests

Mating disruption (MD) technology for management of grape berry moth

See OMAFRA Factsheet, *Mating Disruption for Management of Insect Pests*, Order No. 03-079, for more information.

Many adult insects, usually females, emit volatile chemicals known as sex pheromones to attract members of the opposite sex. When a female moth secretes these chemicals, males respond to the pheromone trail or “plume” and use it to pinpoint her location. Synthetically produced sex pheromones have been used for decades to monitor insect activity patterns.

Mating disruption (MD) technology uses these same chemicals to confuse males and limit their ability to locate pheromone-emitting (“calling”) females. When sufficiently large quantities of synthetic sex pheromones are released into the crop environment, they interfere with mate location by masking the pheromone trail emitted by the female moth. The probability of the male finding the female is reduced, along with the likelihood of successful mating. As a result, mating is either delayed or prevented. The subsequent population is reduced and fewer larvae are present to cause crop damage.

Currently, one pheromone product is available for the management of grape berry moth (GBM) in Ontario. To use Isomate GBM Plus, place the recommended label rate of pheromone dispensers uniformly through the vineyard before first flight of moths in spring.

The advantages of MD technology include:

- The technology is pest specific. Since synthetic pheromones are not harmful to non-target organisms, populations of beneficial mites and insects may increase.
- Pheromones are non-toxic and present no hazard to farm workers.
- Pheromone technology helps with resistance management. MD reduces pressure for development of insect resistance to pesticides and is easily incorporated into IPM programs.
- When applied as directed, pest control is comparable or superior to that obtained through the use of conventional products.

- Pheromone timing is relatively simple; install dispensers in the vineyard before first flight of moths in spring. MD effectiveness does not depend on weather conditions. Apply product as directed on the label.

Insect monitoring, sampling and damage assessments must be conducted throughout the season to ensure that GBM are adequately controlled and to determine if special sprays are necessary for other sporadic pests such as leafhoppers, mites and spring feeding caterpillars. Regular monitoring is critical to the successful implementation of any IPM program.

Choosing a site for mating disruption

Vineyards should be at least 2 ha in size. Mating disruption works best in vineyards with low GBM populations. Avoid vineyards located next to vineyards with known high populations of grape berry moth.

Applying pheromone

It is critical that synthetic pheromones be applied prior to, or at the onset of, moth emergence. Delayed application results in increased mating and reduced control.

- Attach dispensers securely to the upper training wire close to the vines. Dispensers must be applied throughout the vineyard in sufficient numbers to achieve an adequate release of synthetic pheromone throughout the field.
- Wear gloves when you apply pheromone dispensers to avoid cross-contamination with other pheromone products.

Monitoring for grape berry moth

- Use five pheromone traps for vineyards up to 5 ha in size.
- Place traps along a line that transects the vineyard or at the four corners of the vineyard. In addition, place at least one extra trap along the windward edge of the vineyard. Where vineyards are located adjacent to wooded areas, place traps within the border area at least 40 m apart.
- Bait the traps with commercial lures.
- Inspect traps twice weekly on the same days each week and record the number of moths. Replace lures every 6 weeks or as directed by manufacturer. Captures of moths in pheromone traps should be very low to zero in vineyards using MD.

- Inspect vineyards weekly for signs of fruit infestation. Make the fruit inspections along a transect. In addition, carefully inspect border areas, especially those on the windward side, for signs of fruit infestation.
- If more than 5% of the grape clusters are infested with grape berry moth larvae, apply supplemental insecticides using the appropriate timing.

Mating disruption technology prevents mating of grape berry moth adults. However, if mated female moths of this species are present in adjacent areas, migration of these moths into a pheromone treated vineyard reduces the level of control achieved. Sources of mated females include unsprayed vineyards or wild grapevines within 100 m of the treated vineyard. Migration of mated females can be prevented by:

- treatment of entire blocks, not just sections of large conventionally treated fields, with pheromones
- treatment of sources of infestation with pheromone dispensers before moth flight(s)
- treatment of infestation source(s) with an effective insecticide
- treatment of edges of the vineyard with timely insecticide applications

Relative disease susceptibilities

Table 6-5. *Relative Disease Susceptibilities*, on pages 140–141, provides a relative rating of grape variety susceptibility based on observations in Ontario and northeast United States under average conditions. Under adverse weather conditions, for example, extended cool weather, any given variety may be more seriously affected.

TABLE 6-5. Relative Disease Susceptibilities

— = Relative susceptibility is unknown; + = Slightly susceptible; ++ = Moderately susceptible; +++ = Highly susceptible; ++++ = Extremely susceptible.								
Cultivar	Type ^a	Eutypa dead arm	Phomopsis cane blight	Black rot ^b	Downy mildew	Powdery mildew	Botrytis bunch rot	Phytotoxic chemical sensitivity ^c
Vinifera Wine								
Auxerrois	V	—	++	—	+	+++	+++	
Cabernet Franc	V	—	++	+++	++	+++	+	
Cab. Sauvignon	V	++	++	+++	++	+++	+	
Chardonnay	V	+	++	+++	++	++++	++	3
Gamay	V	+	+	+	++	+++	++	
Gewurztraminer	V	++	—	+++	++	+++	+++	
Merlot	V	—	+	++	++	+++	+	5
Pinot Blanc	V	—	—	+++	++	+++	+++	
Pinot Gris	V	—	—	+++	++	+++	+++	
Pinot Noir	V	—	—	+++	++	+++	+++	
Riesling	V	+	+	+++	++	+++	+++	
Sauvignon Blanc	V	—	—	++	++	++	+++	5
Zweigeltrebe	V	—	++	+++	++	+++	+	
Hybrid Wine								
Baco Noir	FH	—	++	+	+	++	+	4
Chambourcin	FH	—	+	++	++	++	+	1,4
Chancellor	FH	—	+	+	+++	+++	++	5
^a Species type		1 = Sulphur sensitive			L = Labrusca			
^b Black rot is more serious adjacent to bush or similar areas with poor air drainage		2 = Dikar + Zolone combination may be phytotoxic			AH = American hybrid			
^c These notes are based on grower experience and could vary under stress conditions		3 = Dikar sensitive			FH = French hybrid			
		4 = Thiodan sensitive			V = Vinifera (vinifera varieties not included in this chart are considered susceptible to powdery mildew)			
		5 = Copper sensitive						
		6 = Flint sensitive						

TABLE 6-5. Relative Disease Susceptibilities (cont'd)

— = Relative susceptibility is unknown; + = Slightly susceptible; ++ = Moderately susceptible; +++ = Highly susceptible; ++++ = Extremely susceptible.

Cultivar	Type ^a	Eutypa dead arm	Phomopsis cane blight	Black rot ^b	Downy mildew	Powdery mildew	Botrytis bunch rot	Phytotoxic chemical sensitivity ^c
Chelois	FH	+++	++	++	+	+++	++	3
Couderc Muscat	FH	—	—	++	—	+++	+	
De Chaunac	FH	+	+++	+	+	++	+	1
Foch	FH	++	++	+	+	++	+	1,2,3
J.S. 23-416	FH	—	+	—	—	++	—	
Rosette	FH	—	++	++	+++	++	+	
Seyval Blanc	FH	—	++	++	++	+++	+++	
S.V. 23-512	FH	—	+	—	—	++	—	
Vidal 256	FH	—	+	+	++	++	+	5
Villard Noir	FH	—	+	—	—	++	+	3,4
Juice & Table								
Concord	L	+	++	++	++	++	+	1,4,5,6
Elvira	L	+++	+++	++	+	++	++	5
Fredonia	L	+	++	++	+++	++	+	
Himrod	AH	—	+	++	+	++	—	
N.Y. Muscat	L	+	—	+	+	++	+	
Niagara	L	++	++	+++	+++	++	+	5
Sov. Coronation	L	—	+	—	—	+	—	
Vanessa	AH	—	+	+++	++	++	+	
^a Species type		1 = Sulphur sensitive			L = Labrusca			
^b Black rot is more serious adjacent to bush or similar areas with poor air drainage		2 = Dikar + Zolone combination may be phytotoxic			AH = American hybrid			
^c These notes are based on grower experience and could vary under stress conditions		3 = Dikar sensitive			FH = French hybrid			
		4 = Thiodan sensitive			V = Vinifera (vinifera varieties not included in this chart are considered susceptible to powdery mildew)			
		5 = Copper sensitive						
		6 = Flint sensitive						

TABLE 6-6. Activity of Fungicides on Grape Diseases

Ratings in shaded cells indicate the disease is listed on the product label for control or suppression. Please see the product label or crop calendars for registered uses. Use fungicides only for diseases listed on the product label for the crop and for the disease. Additional information is provided in this table to assist the grower in choosing the best fungicide for control of diseases listed on the product label.

Group	Fungicide	Phomopsis cane and leaf spot	Black rot	Downy mildew	Powdery mildew	Botrytis bunch rot
M1	Copper	+	++	++	+	0
M1	Kumulus DF	0	0	0	+++	0
M1	Microscopic Sulphur	0	0	0	+++	0
M2	Dikar	+	+++	+++	+++	0
M2	Ferbam 76 WDG	+	+++	++	0	0
M2	Polyram DF	?	+++	+++	0	0
M3	Supra Captan 80 WDG	+++	++	+++	0	0
M3	Folpan 80 WDG	+++	++	+++	0	0
M3	Maestro 80 DF	+++	++	+++	0	0
2	Rovral	0	0	0	+	++
3	Nova 40 W	0	+++	0	+++	0
4	Ridomil Gold MZ	+	++	+++	0	0
7	Lance WDG	?	++	0	+++	++
9	Scala	?	0	0	0	+++
9	Vanguard 75 WG	0	0	0	0	+++
11	Flint 50 WG	+	+++	+	+++	+
11	Sovran	+	+++	++	+++	+
17	Elevate 50 WDG	0	0	0	0	+++
22	Gavel 75DF	?	?	+++	0	0
NC	MilStop	0	0	0	+++	0
NC	Serenade Max	?	?	?	+	+

0 = Ineffective; + = Slightly effective; ++ = Moderately effective; +++ = Very effective; ? = Effect unknown.

7. Tender Fruit

Tender Fruit Nutrition

It is important to test the soil a year in advance of planting fruit trees, or two years where pH adjustment may be necessary. Before planting is the only opportunity to thoroughly incorporate materials that do not move readily through the soil profile but are needed to optimize orchard productivity. These materials include organic matter, phosphorus, potassium, and lime to adjust soil pH.

Manure for Orchards

Manure contains beneficial organic matter and a host of macro and micronutrients. The disadvantage of adding manure to orchards is that the organic nitrogen is mineralized over time. This slow release means the orchard receives a continuous supply of available nitrogen throughout the season. Excessive nitrogen, particularly in the second half of the growing season, can result in poor fruit colour, reduced storability, excessive growth, and delayed cold-hardening of the woody tissue which makes trees more susceptible to winter injury. Observe the following guidelines to receive the benefits of manure while minimizing potential problems:

- Apply no more than 7 tonnes/ha of poultry manure (20 m³ liquid), 40 tonnes/ha of cattle manure (100 m³ liquid) and 35 tonnes/ha hog manure (65 m³ liquid). Since the nutrient content of manure varies greatly, conduct nutrient analysis before application. See *Manure nitrogen*, on page 35.

- Broadcast manure and work into the soil in late fall or early spring before planting. Do not place manure around newly planted trees because of potential winter injury problems.
- Reduce the rate of nitrogen, phosphorus and potassium fertilizers applied. Table 3-12, *Average Fertilizer Replacement Values for Different Types of Manure*, on page 36, shows the average composition of some manures and suggested reduction of fertilizer when manure is used.
- For more information about food safety and the environmental impacts of manure application, see *Manure nitrogen*, on page 35, *Use manure responsibly*, on page 35 and *Manure and food safety*, on page 35.

pH Requirements

The pH of a soil is a measure of its acidity and affects nutrient availability and crop performance. Soil pH should be adjusted to 6.5 on sandy soils and 6.0 on clay soils before you establish a new orchard.

In established orchards, sample soil in the tree row every three years to ensure the pH is satisfactory. If the pH drops below 5.6 on sandy soils or below 5.1 on clay loam soils, apply lime to the sod cover in the fall or before spring cultivation. The results will not be immediate because lime moves and reacts slowly in the soil.

For details regarding suggested rates and types of lime, consult *Soil pH and Liming*, on page 31.

TABLE 7-1. Nutrient Concentration Sufficiency Ranges for Tender Fruits (Mid-shoot Leaves in Late July)

Analysis	N*	P	K	Ca	Mg	Fe	B	Zn	Mn
Crop	%					ppm			
Peach	3.4–4.1	0.15–0.40	2.3–3.5	1.0–2.5	0.35–0.60	25–200	20–60	15–100	20–200
Pear	2.0–2.6	0.15–0.40	1.2–2.0	1.0–2.0	0.25–0.50	25–200	20–60	15–100	20–200
Plum		0.15–0.40	1.5–3.0	1.0–2.5	0.35–0.65	25–200	20–60	15–100	20–200
Cherry (Montmorency)	2.2–3.0	0.15–0.40	1.3–2.5	1.0–2.5	0.35–0.65	25–200	20–60	15–100	20–200

* Leaf nitrogen in non-bearing trees should be 0.2% higher.

Leaf Analysis

In established plantings, leaf analysis is the best method to determine nutrient status of the trees. When used in conjunction with soil analysis, leaf analysis ensures good information for determining fertilizer needs. For more information on these tests see *Plant tissue analysis*, on page 29.

Nutrient uptake is affected by many orchard conditions. Consequently, nutrient levels vary slightly from year to year, depending on the season. For optimum growth and fruit quality, all nutrients must be at concentrations within the sufficiency range in the leaves.

For leaf analysis to be most effective, sample the same trees each year and make adjustments to the fertilizer program on the basis of this leaf analysis. Consult Table 7-1. *Nutrient Concentration Sufficiency Ranges for Tender Fruits*, on page 143.

Fertilizer requirements are adjusted to soil management practices, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered to determine the fertilizer required. Further information is available in OMAFRA Factsheet, *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

TABLE 7-2. Phosphorus and Potassium Soil Requirements Before Planting Tender Fruit Trees

Soil phosphorus		Soil potassium	
New plantings of peaches, pears, plums, cherries		New plantings of peaches, pears, plums, cherries	
Soil test (ppm P)	Phosphate (P_2O_5) req'd kg/ha	Soil test (ppm K)	Potash (K_2O) req'd kg/ha
0–3	80 HR	0–15	180 HR
4–5	60 HR	16–30	170 HR
6–7	50 HR	31–45	160 HR
8–9	40 MR	46–60	140 HR
10–12	20 MR	61–80	110 HR
13–15	0 LR	81–100	70 MR
16–20	0 LR	101–120	40 MR
21–25	0 RR	121–150	20 MR
26–30	0 RR	151–180	0 LR
31–40	0 RR	181–210	0 LR
41–50	0 RR	211–250	0 RR
51–60	0 RR	250 +	0 NR
61–80	0 NR		
80 +	0 NR		

- For established fruit trees, plant analysis is used to estimate requirements of N, P and K.
- HR, MR, LR, RR, and NR denote, respectively, high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

Fertilizer for Tender Fruit

Fertilizer for non-bearing tender fruit

The best time to effectively incorporate nutrients such as phosphorus, potassium, boron and lime is before planting. Adequate nutrient levels in the topsoil for orchard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. Table 7-2. *Phosphorus and Potassium Soil Requirements Before Planting Tender Fruit Trees*, on this page, provides information on fertilizer rates prior to planting.

Along with the incorporation of organic matter, these fertility levels will sustain the tree in the juvenile years.

- On coarse-textured, infertile soils, use a starter solution at planting time such as 10-52-10 or 20-20-20.
- High nitrogen levels can result in excessive growth and incomplete tree hardening. Use cover crops to reduce late season nitrogen levels in cultivated orchards, especially in new plantings. Cover crops such as Italian ryegrass should be sown about July 1 to take up much of the available nitrogen in the soil.
- On young trees, broadcast the fertilizer under the spread of the branches at least 15 cm from the trunk, since injury can occur if placed too close.

Fertilizer for bearing tender fruit trees

Most bearing orchards require annual applications of both nitrogen and potassium fertilizer. These two elements significantly affect growth and productivity.

Nitrogen (N)

Nitrogen is necessary for many tree functions, which include growth, fruit bud formation, fruit set and fruit size. Cultivars differ in nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In situations where fruit tends to be small, more nitrogen may be needed. Rootstocks, spacing and pruning also affect application rates. Tree growth, fruit colour and storability are also important considerations. Because of the complexity of nitrogen interactions with quality

and production, the best guide for nitrogen rates is leaf analysis.

For pear, peach, plum and cherry orchards where leaf analysis is not available, the following rates are considered normal.

- For each year of tree's age, apply between 30–40 grams of nitrogen. Thus, a five-year-old tree in sod culture requires 150–200 g of nitrogen. See Table 7-3. *Actual Nitrogen Rates per Tree in Sod Culture*, on this page. The rate for cultivated orchards can be cut in half as competition for nutrients is greatly reduced. Trees on dwarfing rootstock generally require more nitrogen per ha (not per tree) than trees on more vigorous stocks. When the tree canopy has covered the space available, nitrogen fertilizer requirements level out and do not increase with tree age. Again leaf analysis is the most reliable guide.
- There are several forms of nitrogen available. Do not apply urea (46-0-0) to sod orchards since some nitrogen is lost by volatilization.
- For all tree fruits do not exceed the maximum rates of 200 kg actual nitrogen per ha per year, even in cases of severe deficiency. Late or excessive applications of nitrogen result in poor fruit colour and quality. Available nitrogen late in the season also encourages the tree to grow instead of harden off, which potentially leads to winter injury.
- In cultivated orchards, use cover crops to help lower the nitrogen level in the latter part of the season. Cover crops such as Italian ryegrass, sown about July 1, will take up much of the available nitrogen in the soil and limit tree growth.
- In orchards with herbicide-treated strips under trees, allow some weed growth late in the season. Weeds take up extra nitrogen, which helps to harden off trees and improve fruit quality.
- If pruning is to be severe, reduce nitrogen rates or eliminate it for a year.
- During dry springs, irrigate to move the fertilizer into the rooting zone of the soil just before first bloom or immediately after petal fall.
- For fire blight-sensitive pear cultivars, use less than the maximum rate of nitrogen suggested.

Nitrogen placement and timing

- Apply nitrogen fertilizer in early April.

- In cultivated orchards, broadcast nitrogen under the tree canopy.
- In sod orchards, place the nitrogen in a band under the drip line or in the herbicide strip.
- If there is evidence of fruit bud damage due to severe winter temperatures, it may be necessary to split nitrogen applications. Apply the first application in mid-April and the second, if necessary, after bloom in late May.

Foliar application of nitrogen

When weather or crop conditions create a need for additional nitrogen at a critical time, foliar applications of urea (46% nitrogen) have been successfully used on fruit trees. Late applications adversely affect fruit quality and winter survival of the tree.

- Do not rely on foliar sprays to completely substitute for soil applications if nitrogen is required. There are several formulations of foliar nitrogen. In some years, make applications based on tree performance and leaf analysis.

TABLE 7-3. Actual Nitrogen Rates per Tree in Sod Culture

YEAR or TREE AGE	ACTUAL NITROGEN per TREE (grams)		
	Number of trees per ha (trees per ac)		
Planting Year	400 (160)	500 (200)	600 (240)
	0	0	0
1	40	40	40
2	80	80	80
3	120	120	120
4	160	160	160
5	200	200	180
6	240	240	240
7	280	280	260
8	320	320	280
9	360	360	300
10	400	400	320
11	440	400	320
12	480	400	320

Phosphorus (P)

Phosphorus is not required in large amounts by fruit trees. With a few exceptions, the level of phosphorus in Ontario soils is adequate. Phosphorus may be required for sod or cover crop maintenance. A soil test is the best way to determine if the sod needs this nutrient.

If indicated by a soil test, apply phosphorus before planting an orchard when it can be thoroughly incorporated into the soil. Phosphorus soil test values between 12–20 ppm are considered adequate for establishment and fruit production.

Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and resistance to disease, such as fire blight in pears. Excess potassium can lead to magnesium (Mg) deficiency, so avoid unnecessary application of potassium. Soil test values between 120–150 ppm are adequate when planting fruit trees. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available the following rates are considered normal.

Trees one to six years of age regardless of density

- Apply 50 g K_2O (80 g muriate of potash) per 2.5 cm of trunk cross-section (diameter).

Trees seven years of age or older

- Apply no more than 3 kg of K_2O (5 kg muriate of potash) per mature standard tree in a year, regardless of how severe the deficiency. When the tree canopy has covered the space available, potassium fertilizer requirements level out and do not increase indefinitely with tree age. Again, leaf analysis is the most reliable guide.

Placement and timing

- In early spring, apply potassium separately or combined with nitrogen. Some growers make fall applications because of time constraints in the spring. Leaching during winter may cause the loss of some potassium. For this reason, apply in spring if possible.
- In sod orchards, apply potash in a band around the drip line or in the herbicide strip.

Foliar application of potassium

In dry growing seasons, potassium is not readily available to the plant. Foliar applications of potassium may be used where potassium deficiency is confirmed.

Magnesium (Mg)

Magnesium deficiency has become more evident in orchards, particularly when high rates of potash are used. Magnesium deficiency can lead to premature drop of fruit at harvest.

As magnesium is a part of the chlorophyll molecule, trees deficient in magnesium have older leaves that are pale in colour. Leaf analysis is the best way to evaluate magnesium needs.

Foliar sprays of magnesium are effective to correct magnesium deficiency for the current year only. For more permanent correction, soil applications of magnesium are required. Magnesium soil test values between 100–250 ppm are considered adequate when planting fruit trees. See Table 7-4. *Magnesium Foliar Sprays*, on page 147.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate.

- Apply magnesium sulfate separately or try it on a few trees first. Check manufacturer's label in regard to the mixture of magnesium chelates¹ with pesticides.
- For long-term corrections, apply magnesium to the soil. The response is not immediate. On some soil types a single early spring application of soil-applied magnesium does not work and a second or third application the following spring may be required before the magnesium level in the tree improves.
- To be sure that fruit drop is not a problem during this waiting period, apply foliar sprays for the first two years in addition to soil applications.
- For soil corrections, apply 5–7 kg per mature standard tree and 3–4 kg per mature dwarf tree of sulphate of potash magnesia. This is a granular fertilizer known by several trade names. It contains approximately 21% potash and 11% magnesium. Apply in early spring in a band under the tree drip line. It contains potassium (K) and the rate of application depends on potash needs. No further potash (e.g. 0-0-60) is needed, but apply nitrogen at recommended rates. Other sources of magnesium also work well as a soil application.
- If magnesium is being blended with the fertilizer, apply at least 80 kg of available magnesium per ha when the fertilizer is spread.
- Use dolomitic limestone on acidic soils to raise the soil pH and to supply magnesium.

¹ Use chelates recommended for foliar sprays.

TABLE 7-4. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
3 sprays spaced 2 weeks apart beginning at calyx	Magnesium sulfate (Epsom salts)	20 kg/1,000 L water	Wet tree to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

Calcium (Ca)

Lack of calcium is associated with fruit problems in pear and gummosis in European plums and prunes. Some formulations of calcium chloride (CaCl_2) result in poor fruit finish if applied too close to harvest. Calcium sprays must contact the fruit for uptake to be effective; therefore water volumes capable of wetting the entire tree are required. The more calcium applied, the better the control; however excessive calcium can cause foliage to burn. The product used is not as important as the total amount of actual (elemental) calcium applied.

Use CaCl_2 (77% flakes) at 4 kg/1,000 L of water from early July to mid-August. Apply three sprays, 10–12 days apart. For acceptable results up to 12 kg/ha of actual calcium is often required in a total of four or more sprays. Calcium sprays may injure foliage and fruit if applied during low temperatures and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather. Do not apply calcium formulations containing nitrogen after

the end of July or fruit quality and storability may suffer. For all formulations, consult label directions for concentrations to use and compatibility with pesticides.

Micronutrients for Tender Fruit

Deficiencies of micronutrients or trace elements are not widespread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible with excess amounts rather than deficiencies. Leaf analysis is more effective than soil analysis to evaluate a crop's micronutrient status. For more information see *Micronutrients*, on page 40.

- Do not apply micronutrients to fruit crops unless leaf analysis confirms a deficiency.
- Apply only the nutrient that is deficient in sufficient quantities to correct the problem.

Warning: Do not concentrate nutrient sprays.

Do not spray at temperatures above 25°C.

Apricot Calendar

Read the label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, on page 13.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-5. *Products Used on Apricots*, on page 150.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant (in late March or early April before buds swell)			
European red mite	• Superior 70 Oil	20 L/1,000 L water	Apply in a high volume spray to ensure thorough coverage. Do not apply Captan or Maestro within 14 days of oil.
Prebloom (when blossom buds show pink)			
Brown rot	• Topas 250 E	500 mL	Apricots are extremely susceptible to brown rot at blossom time and just before picking. To avoid resistance, do not apply Topas/Mission, Rovral, Indar, Lance or Vanguard more than two times for each product per season. Alternate between fungicide families and do not use the same product in consecutive sprays. See <i>Pest Resistance to Insecticides, Fungicides, Miticides</i> , on page 13 and Table 7-5. <i>Products Used on Apricots</i> , on page 150. Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance. Topas/Mission and Indar: From the same chemical family. Do not alternate Topas/Mission and Indar.
Blossom blight	• or Mission 418 EC	300 mL	
	• Rovral	1.50 kg	
	• Supra Captan 80 WDG	4.50 kg	
	• or Maestro 80 DF	4.50 kg	
	• Vanguard 75 WG	370 g	
	• Indar 75 WSP	140 g	
	• Lance WDG	370 g	
	• Pristine WG	750 g	
DO NOT APPLY INSECTICIDES WHILE APRICOT TREES ARE IN BLOOM. SEE BEE POISONING, ON PAGE 192.			
Shuck split (when about 50% of shucks have split)			
Brown rot	• Topas 250 E	500 mL	Apricots are extremely susceptible to brown rot. To avoid resistance, do not apply Topas/Mission, Rovral, Indar, Lance or Vanguard more than two times for each product per season. Alternate between fungicide families and do not use the same product in consecutive sprays. Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance. Topas/Mission and Indar: From the same chemical family. Do not alternate Topas/Mission and Indar.
	• or Mission 418 EC	300 mL	
	• Rovral	1.50 kg	
	• Supra Captan 80 WDG	4.50 kg	
	• or Maestro 80 DF	4.50 kg	
	• Vanguard 75 WG	370 g	
	• Indar 75 WSP	140 g	
	• Lance WDG	370 g	
	• Pristine WG	750 g	
Plum curculio	• Guthion 50 WSB	see label	Apricots are very susceptible to plum curculio. Scout edges of orchards near woodlots and wild hosts in spring. Check small fruit for crescent-shaped egg laying scars. Damage often occurs only on the border of the orchard. Check developing fruit for new damage 7–10 days after insecticide is applied.
	• or Sniper	see label	
	• Sevin XLR	6.25 L	
Shuck fall (10–12 days after last spray)			
Brown rot	• Topas 250 E	500 mL	Choose a different product than used previously this season. Rotate products from different families. Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance. Topas/Mission and Indar: From the same chemical family. Do not alternate Topas/Mission and Indar.
	• or Mission 418 EC	300 mL	
	• Rovral	1.50 kg	
	• Supra Captan 80 WDG	4.50 kg	
	• or Maestro 80 DF	4.50 kg	
	• Vanguard 75 WG	370 g	
	• Indar 75 WSP	140 g	
	• Lance WDG	370 g	
	• Pristine WG	750 g	

Diseases and Insects	Materials	Amount/ha	Comments
Plum curculio	<ul style="list-style-type: none">• Guthion 50 WSB or Sniper• Sevin XLR	see label see label 6.25 L	
Lesser peachtree borer	<ul style="list-style-type: none">• Thiodan 50 WP or Thionex 50 W	1.50 kg/1,000 L	Peachtree borers are sporadic pests of apricots. In areas with high borer populations, follow this spray regime. Use pheromone traps to monitor adult activity and begin sprays one week after first flight. Make three applications at 5–10 day intervals. Direct these sprays with a handgun to cover trunk and scaffold limbs thoroughly; do not spray fruit. Check the Preharvest interval (days), on page 150.
Peachtree borer	<ul style="list-style-type: none">• Thiodan 4 EC	1.50 kg/1,000 L	
	<ul style="list-style-type: none">• Sevin XLR	1.75 L/1,000 L 6.25 L	
First cover (10–12 days after Shuck fall)			
Brown rot	Use one of the fungicides listed under Shuck split .		
Plum curculio	Use one of the insecticides listed for plum curculio at Shuck split .		
Special sprays (when monitoring indicates the need)			
European red mite	<ul style="list-style-type: none">• Envidor 240 SC• Kelthane 50 W	0.75 L 3.25 kg	European red mite is a sporadic pest and is rarely a problem in apricot orchards. Apply when red mites build up to 10 active stages per leaf in the absence of beneficial predatory mites. Do not apply Kelthane or Envidor more than once per season.
Leafrollers	<ul style="list-style-type: none">• Success 480 SC or Entrust 80 W• Dipel 2X DF or Bioprotec CAF	182 mL 109 g 1.12 kg 4.00 L	B.t. products (Dipel, Bioprotec): Make two applications at 5–7 day intervals if activity of the larvae is extended. B.t. products work best if applied in the evening or on a cloudy day.
Prepick to harvest			
Brown rot	Use one of the fungicides listed under Shuck split .		Apricots are extremely susceptible to brown rot just before picking. Additional sprays may be required during harvest if conditions are wet. The rate for Vanguard at this time is 740 g/ha.
Postharvest fruit treatment			
Blue mould, grey mould, brown rot, rhizopus rot	<ul style="list-style-type: none">• Scholar 50 WP	227 g/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions.

TABLE 7-5. Products Used on Apricots

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Bioprotec CAF	<i>Bacillus thuringiensis</i>	B.t. microbial	1		
Dipel 2X DF	<i>Bacillus thuringiensis</i>	B.t. microbial	1		
Entrust 80 W	spinosad	naturalyte	14		3
Envidor 240 SC	spirodiclofen	tetronic acid derivative	7	12 hours	1
Guthion 50 WSB	azinphosmethyl	organophosphate	21	14 days	2
Indar 75 WSP	fenbuconazole	triazole (DMI)	1	12 hours	7
Kelthane 50 W	dicofol	diphenylethane	14		1
Lance WDG	boscalid	anilide carboxamide	0	4 hours	5
Maestro 80 DF	captan	phthalimide	2	48 hours	
Mission 418 EC	propiconazole	triazole (DMI)	3	72 hours	5*
Pristine WG	boscalid + pyraclostrobin	anilide carboxamide + QoI	0	24 hours for hand harvest, 10 days for hand thinning	5
Rovral	iprodione	dicarboximide	1	12 hours	
Scholar 50 WP	fludioxonil	phenylpyrrole	postharvest		
Sevin XLR	carbaryl	carbamate	5		
Sniper	azinphosmethyl	organophosphate	21	14 days	2
Success 480 SC	spinosad	naturalyte	14		3
Superior 70 Oil	mineral oil		prebloom only		
Supra Captan 80 WDG	captan	phthalimide	2	48 hours	
Thiodan 4 EC	endosulfan	chlorinated cyclodiene	15		3
Thiodan 50 WP	endosulfan	chlorinated cyclodiene	15		3
Thionex 50 W	endosulfan	chlorinated cyclodiene	15		3
Topas 250 E	propiconazole	triazole (DMI)	3	72 hours	5*
Vangard 75 WG	cyprodinil	anilinopyrimidine	2	72 hours	4

* No more than two applications during the 3 weeks prior to harvest.

Sour Cherry Calendar

Read the label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, on page 13.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-6. *Products Used on Sour Cherries*, on page 154.

Diseases and Insects	Materials	Amount/ha	Comments
Prebloom			
European red mite	• Superior 70 Oil	20 L/1,000 L water	Only needed in sour cherry orchards with a heavy mite population. Spray as buds are breaking. Mature trees require water volumes of approximately 3,000 L/ha for thorough coverage. Captan, Maestro or Bravo: Do not apply within 14 days of oil.
Bloom			
DO NOT APPLY INSECTICIDES WHILE CHERRY TREES ARE IN BLOOM. SEE BEE POISONING ON PAGE 192.			
Brown rot (stem rot and blossom blight stages)	<ul style="list-style-type: none"> • Topas 250 E or Mission 418 EC • Nova 40 W • Rovral • Bravo 500 • Supra Captan 80 WDC or Maestro 80 DF • Funginex DC • Kumulus DF • Elevate 50 WDC • Lance WDC • Indar 75 WSP • Pristine WG 	500 mL 300 mL 340 g 1.50 kg 7.00 L 4.50 kg 2.50 L 22.50 kg 1.70 kg 370 g 140 g 750 g	Spray just before blooms open if weather conditions are expected to be wet and warm (above 16°C) during bloom. Sour cherries are less susceptible to brown rot than sweet cherries. One application during bloom should be sufficient, unless frequent wet periods occur and brown rot pressure is high. Captan, Maestro or Bravo: Do not use within 14 days of an oil application. To avoid resistance do not apply Topas/Mission, Rovral, Elevate, Indar or Lance more than two times for each product per season. Alternate between fungicide families and do not use the same product in consecutive sprays. See <i>Pest Resistance to Insecticides, Fungicides, Miticides</i> , on page 13. Nova and Topas/Mission: Absorbed by flower parts, making these materials more rainfast than other protectant fungicides. Topas/Mission: Also suppress black knot. Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance. Topas/Mission and Indar: From the same chemical family. Do not alternate Topas/Mission and Indar.
Petal fall			
Leaf spot	<ul style="list-style-type: none"> • Bravo 500 • Supra Captan 80 WDC or Maestro 80 DF • Nova 40 W • Ferbam 76 WDC • Equal 65 WP • Topas 250 E or Mission 418 EC • Pristine WG 	7.00 L 4.50 kg 4.50 kg 340 g see label 2.25 kg 500 mL 300 mL 750 g	Spray only if rain is forecast between Bloom and Shuck sprays. Alternate fungicides from different chemical families. Bravo: Make one application of Bravo 500 to control early season leaf spot. After shuck split, rotate with other products as a resistance management strategy.

Diseases and Insects	Materials	Amount/ha	Comments
Black knot	<ul style="list-style-type: none">• Bravo 500• Indar 75 WSP• Topas 250 E or Mission 418 EC	7.00 L 140 g 500 mL 300 mL	<p>This spray is only needed on sour cherry orchards with a history of black knot. Prune out, remove and burn all black knots from commercial orchards during dormant period before bud break. Remove any wild infected cherry hosts surrounding commercial orchards. See OMAFRA Factsheet <i>Black Knot of Plums</i>, Order No. 05-017, for more information.</p> <p>Topas/Mission: Provides suppression of black knot. See label.</p>
Shuck			
Plum curculio	<ul style="list-style-type: none">• Guthion 50 WSB or Sniper• Zolone Flo• Imidan 50 WP	see label see label 2.00 L 3.75 kg	<p>Spray when most shucks are off and plum curculio activity is observed.</p> <p>Zolone: Also helps control aphids. Maximum three applications of Zolone per season.</p>
Brown rot	<ul style="list-style-type: none">• Topas 250 E or Mission 418 EC• Bravo 500• Supra Captan 80 WDG or Maestro 80 DF• Rovral• Elevate 50 WDG• Lance WDG• Indar 75 WSP• Pristine WG	500 mL 300 mL 7.00 L 4.50 kg 4.50 kg 1.50 kg 1.70 kg 370 g 140 g 750 g	<p>To avoid resistance, do not apply Topas/Mission, Rovral, Elevate, Indar, or Lance more than two times for each product per season. Alternate between fungicide families and do not use the same product in consecutive sprays.</p> <p>Topas/Mission: No more than two applications in the 3 weeks prior to harvest. Topas/Mission will also suppress black knot.</p> <p>Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.</p>
Leaf spot	Use one of the fungicides recommended at Petal Fall with the exception of Ferbam.		
European red mite	<ul style="list-style-type: none">• Pyramite or Nexter• Kelthane 50 W	300 g 300 g 3.25 kg	<p>Thorough coverage is necessary for good mite control. Only needed in heavily infested sour cherry orchards.</p>
Black knot	<ul style="list-style-type: none">• Bravo 500• Indar 75 WSP	7.00 L 140 g	<p>This spray is only needed on sour cherry orchards with a history of black knot. Prune out, remove and burn all black knots from commercial orchards during dormant period before bud break. Remove any wild infected cherry hosts surrounding commercial orchards. Spore release may be delayed in dry springs. Under these conditions extend fungicide coverage to first cover. See OMAFRA Factsheet <i>Black Knot of Plums</i>, Order No. 05-017, for more information.</p> <p>Bravo: Do not apply after shuck split to avoid fruit injury.</p>
First cover (12 days after shuck)			
Plum curculio	Use one of the insecticides listed under Shuck .		<p>Monitor 7 days after the insecticide at shuck fall for new plum curculio damage. If new crescent-shaped cuts on fruit are found, then apply an insecticide.</p> <p>Zolone: Helps control aphids.</p>
Obliquebanded leafroller	<ul style="list-style-type: none">• Dipel 2X DF or Bioprotec CAF• Success 480 SC or Entrust 80 W	1.12 kg 4.00 L 182 mL 109 g	<p>Routine monitoring is necessary to determine if obliquebanded leafrollers are causing damage in sour cherries.</p>
Leaf spot	Use one of the fungicides listed under Petal fall with the exception of Ferbam.		
Special sprays (when monitoring indicates the need)			
European red mite	<ul style="list-style-type: none">• Envidor 240 SC	750 mL	

Diseases and Insects	Materials	Amount/ha	Comments
Second cover (12 days after First cover)			
Cherry fruit fly	<ul style="list-style-type: none">Imidan 50 WPDiazinon 50 WZolone FloGF-120 NFor Entrust 80 WGuthion 50 WSB or Sniper	<ul style="list-style-type: none">3.75 kg3.00 kg2.00 L1.50 L109 gsee labelsee label	<p>GF-120 NF: Spray as soon as monitoring traps indicate flies are present or 2–3 weeks before ripening. GF-120 is a bait formulation that requires large droplet size (4–6 mm); specialized application equipment may be needed. GF-120 will lose effectiveness if exposed to rain or overhead irrigation.</p> <p>Diazinon, Zolone, Guthion and Imidan: On early varieties, check preharvest interval. Spray when early varieties are beginning to colour.</p> <p>Diazinon: Provides 10 days protection against cherry fruit fly.</p> <p>Zolone: Provides 12–14 days protection against cherry fruit fly. Maximum three applications of Zolone per season.</p>
Plum curculio	<ul style="list-style-type: none">Guthion 50 WSB or SniperZolone FloImidan 50 WP	<ul style="list-style-type: none">see labelsee label2.00 L3.75 kg	
Obliquebanded leafroller	<ul style="list-style-type: none">Dipel 2X DF or Bioprotec CAFSuccess 480 SC or Entrust 80 W	<ul style="list-style-type: none">1.12 kg4.00 L182 mL109 g	Routine monitoring is necessary to determine if obliquebanded leafrollers are causing damage in sour cherries.
Leaf spot	Use one of the fungicides recommended at Petal Fall with the exception of Ferbam.		
Powdery mildew	<ul style="list-style-type: none">Nova 40 WKumulus DFCabrio EGPristine WG	<ul style="list-style-type: none">340 g12.00 kg670 g750 g	<p>Kumulus: Suppresses powdery mildew at this rate. Higher rates may cause injury.</p> <p>Cabrio: Make no more than two consecutive applications, then alternate with fungicides from different families. Cabrio will also suppress brown rot.</p> <p>Pristine and Cabrio: Include active ingredients in the same fungicide family. Do not alternate Pristine with Cabrio.</p> <p>Pristine: Provides suppression of powdery mildew.</p>
Third cover			
Cherry fruit fly	<ul style="list-style-type: none">Imidan 50 WPDiazinon 50 WZolone FloGF-120 NFor Entrust 80 WSevin XLR	<ul style="list-style-type: none">3.75 kg3.00 kg2.00 L1.50 L109 g6.25 L	<p>GF-120 NF: Spray as soon as monitoring traps indicate flies are present or 2–3 weeks before ripening. GF-120 is a bait formulation that requires large droplet size (4–6 mm); specialized application equipment may be needed. GF-120 will lose effectiveness if exposed to rain or overhead irrigation.</p> <p>Sevin, Imidan, Zolone and Diazinon: Spray sour cherries about the time Montmorency is turning pink.</p> <p>Sevin: Provides 5–7 days protection.</p> <p>Zolone: Maximum three applications per season.</p>
Leaf spot	Use one of the fungicides listed under Petal Fall with the exception of Ferbam.		
Preharvest			
Brown rot	Use one of the fungicides listed under Bloom except Funginex.		
Postharvest			
Leaf spot	<ul style="list-style-type: none">Bravo 500Supra Captan 80 WDG or Maestro 80 DFNova 40 WFerbam 76 WDGEqual 65 WPPristine WG	<ul style="list-style-type: none">7.00 L4.50 kg4.50 kg340 gsee label2.25 kg750 g	Necessary where leaf spot is a problem.

Diseases and Insects	Materials	Amount/ha	Comments
Powdery mildew	<ul style="list-style-type: none"> Cabrio EG Pristine WG 	670 g 750 g	<p>Cabrio: Make no more than two consecutive applications then alternate with fungicides from different families. Cabrio will also suppress brown rot.</p> <p>Pristine and Cabrio: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Cabrio.</p> <p>Pristine: Provides suppression of powdery mildew.</p>
European red mite	<ul style="list-style-type: none"> Kelthane 50 W 	3.25 kg	Apply if mites can easily be found on the leaves at this time and predator mites are not present.
Special sprays (when monitoring indicates the need)			
Aphids	<ul style="list-style-type: none"> Diazinon 50 W Thiodan 50 WP or Thionex 50 W Zolone Flo 	3.00 kg 3.25 kg 3.25 kg 2.00 L	<p>These may be added to a compatible fungicide after bloom. Thorough coverage and a calm, warm day are necessary for good aphid control.</p> <p>Zolone: Maximum three applications per season.</p> <p>Zolone Flo and Diazinon 50 W: Are registered for black cherry aphid only.</p>
Peachtree borer	<ul style="list-style-type: none"> Thiodan 50 WP or Thionex 50 W Sevin XLR 	1.5 kg/1,000 L 1.5 kg/1,000 L 6.25 L	Apply first spray 7 days after first adult catch in pheromone traps. Spray up to three times if needed, at weekly intervals. Direct these sprays with a handgun to cover the trunk and scaffold limbs thoroughly. Check preharvest intervals, especially for the second and third sprays and do not apply if the fruit is to be harvested during this period.
Postharvest fruit treatment			
Blue mould, grey mould, brown rot, rhizopus rot	<ul style="list-style-type: none"> Scholar 50 WP 	227 g/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions.

TABLE 7-6. Products Used on Sour Cherries

Use this table as a guide but refer to product label for specific information.

The **preharvest** interval is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Bioprotec CAF	<i>Bacillus thuringiensis</i>	B.t. microbial	1		
Bravo 500	chlorothalonil	chloronitrile	40	48 hours	3*
Cabrio EG	pyraclostrobin	strobilurin	10	10 days for hand labour	5
Diazinon 50 W	diazinon	organophosphate	10		
Dipel 2X DF	<i>Bacillus thuringiensis</i>	B.t. microbial	1		
Elevate 50 WDG	fenhexamid	hydroxylaniline	1	4 hours	4
Entrust 80 W	spinosad	naturalyte	7		4
Envirdor 240 SC	spirodiclofen	tetronic acid derivative	7	12 hours	1
Equal 65 WP	dodine	guanidine	7		
Ferbam 70 WDG	ferbam	dithiocarbamate	4		
* Preharvest.					
** No more than two applications in the 3 weeks prior to harvest.					

TABLE 7-6. Products Used on Sour Cherries (cont'd)

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Funginex DC	triforine	piperazine	do not apply after bloom		3
GF-120 NF	spinosad	naturolyte/spinosyns	0		10
Guthion 50 WSB	azinphosmethyl	organophosphate	15	15 days	2
Imidan 50 WP	phosmet	organophosphate	7		
Indar 75 WSP	fenbuconazole	triazole (DMI)	1	12 hours	7
Kelthane 50 W	dicofol	diphenylethane	7		1
Kumulus DF	sulphur	inorganic	1		
Lance WDG	boscalid	anilide carboxamide	0	4 hours	5
Maestro 80 DF	captan	phthalimide	5	48 hours	
Mission 418 EC	propiconazole	triazole (DMI)	3	72 hours	5**
Nexter	pyridaben	pyridazinone	7	24 hours	1
Nova 40 W	myclobutanil	triazole (DMI)	1		
Pristine WG	boscalid + pyraclostrobin	anilide carboxamide + Qol	0	24 hours for hand harvest, 10 days for hand thinning	5
Pyramite	pyridaben	pyridazinone	7	24 hours	1
Rovral	iprodione	dicarboximide	1	12 hours	
Scholar 50 WP	fludioxonil	phenylpyrrole			
Sevin XLR	carbaryl	carbamate	2		
Sniper	azinphosmethyl	organophosphate	15	15 days	2
Success 480 SC	spinosad	naturolyte/spinosyn	7		3
Supra Captan 80 WDG	captan	phthalimide	5	48 hours	
Thiodan 50 WP	endosulfan	chlorinated cyclodiene	15		3
Thionex 50 W	endosulfan	chlorinated cyclodiene	15		3
Topas 250 E	propiconazole	triazole (DMI)	3	72 hours	5**
Zolone Flo	phosalone	organophosphate	14	24 hours	3

* Preharvest.

** No more than two applications in the 3 weeks prior to harvest.

Growth Regulators for Sour Cherries

Ethephon to promote fruit loosening of sour cherries

Ethephon (Ethrel) can be used in sour cherry orchards to promote fruit loosening, uniform maturity and to facilitate mechanical harvest.

The effectiveness of Ethrel treatment depends on several factors, particularly ambient temperature and tree vigour. The response time of the tree to Ethrel application increases with higher temperatures and decreases at lower temperatures. For this reason, apply Ethrel only in the temperature range of

18–30°C. Remember, hot weather shortens the time needed for response.

- **Tree Vigour:** Tree vigour also affects the effectiveness of Ethrel treatment. Do not spray trees that have low vigour or are severely stressed by drought, disease or winter injury, which is indicated by gumming on the trunk and scaffold limbs. Treat only trees that are vigorous and in good health.
- **Rates:** Apply ethephon at a rate of 2.75 L/ha (applied in approx. 2,400 L of water per ha). Fruit should be in Stage III of growth and enlarging rapidly, with the grass-green color beginning to

turn yellow or develop a tinge of red. This generally coincides with 7–14 days before anticipated harvest. This rate provides an adequate response to enhance fruit loosening to facilitate mechanical harvesting. Consult the product manufacturer for further information.

- **Concentrate spraying:** Application of ethephon in concentrate sprays (i.e., 1,000 L of water per ha or less) achieves the same level of loosening at lower rates per ha as dilute applications. Uniform coverage is important.
- **Tank-mixing:** There is little or no data regarding tank-mixing ethephon. Do not tank mix with foliar nutrients or compounds such as fruit-cracking inhibitors, etc. While no problems have been reported by growers for tank-mixing ethephon with the fungicides and insecticides commonly used at this time, it is possible these materials may act as a buffer to the ethephon and thereby alter activity.

Cherry yellows virus and use of gibberellic acid

To moderate early production, apply gibberellic acid (GA) at 15 ppm in the fourth year. This allows flowering in year five at a reasonable level rather than allowing heavy bloom and production that may significantly reduce growth in future years.

For mature Montmorency sour cherry trees infected with yellows virus, apply GA annually. This helps maintain and extend high fruiting capacity and reduces occurrence of blind nodes through the stimulation of lateral shoots and spurs.

- Apply about 3 weeks after full bloom, from shuck fall to 2 weeks after shuck fall. Use concentrations of 10–20 ppm (15 ppm is most common). Use lower rates on more vigorous trees. For specific application instructions, which include temperature and humidity, consult the product label.

Using GA to encourage vegetative growth in cherry trees

Gibberellic acid treatments are currently being investigated for their potential in Ontario on:

- young tart and sweet cherry trees to reduce flowering and fruiting and to maximize vegetative growth

- mature tart cherries to increase fruiting capacity by stimulating the development of lateral shoots and spurs

Application of GA must be made the year prior to the desired result. Applications should be made when temperatures are expected to be above (21°C) for several days, if possible.

For non-bearing young tart and sweet cherry trees, do not treat in the planting year. Apply in the second year to prevent flowering the third season and repeat the third year to prevent flowering the fourth year. Apply a single application of 100 ppm at 3–4 weeks after normal bloom time, when trees have about five to seven leaves or three to five fully expanded leaves on terminal growth. If tree vigour is low, two applications at 50 ppm about 2½–3 weeks apart are more effective than a single application at 100 ppm. Do not treat more than twice in one year.

After these early year applications of high GA rates, it is very important to bring trees into bearing gradually and not discontinue GA all at once, which may result in oversetting of fruit and stunting of growth. For cultivars grown using standard non-bearing rootstocks (e.g. Mazzard), in the fourth year apply GA at a rate of 30–40 ppm. Decrease the rate to 15–20 ppm in the fifth year. This will allow flowering in years five and six, at reasonable levels. It will also avoid the extremely heavy bloom and production that often occurs, and significantly reduces growth in future years. GA use may then be discontinued or, for weak orchards, repeated annually at 10–15 ppm to promote a more moderate crop level.

In mature tart cherry trees, GA can help maintain and extend high fruiting capacity and reduce the occurrence of blind nodes by stimulating lateral shoots and spurs. Apply about 3 weeks after full bloom at rates of 10–20 ppm. Typically lower rates are used on more vigorous orchards or those where GA has been successfully used in the past. Do not use surfactants and adjuvants until more research is completed, as responses have varied from phytotoxicity to no effect.

Sweet Cherry Calendar

Read the label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point. For resistance management, refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, on page 13.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-7. *Products Used on Sweet Cherries*, on page 159.

Diseases and Insects	Materials	Amount/ha	Comments
Bloom			
DO NOT APPLY INSECTICIDES WHILE CHERRY TREES ARE IN BLOOM. SEE BEE POISONING ON PAGE 192.			
Brown rot (stem rot and blossom blight stages)	<ul style="list-style-type: none"> Topas 250 E or Mission 418 EC Nova 40 W Rovral Bravo 500 Supra Captan 80 WDG or Maestro 80 DF Funginex DC Elevate 50 WDG Lance WDG Indar 75 WSP Pristine WG 	500 mL 300 mL 340 g 1.75 kg 7.00 L 4.50 kg 4.50 kg 2.50 L 1.70 kg 370 g 140 g 750 g	<p>Blossom blight is favoured by wet, warm (above 16°C) weather, especially when large numbers of mummies are present in the trees. Apply first spray just before blossoms open, followed by two additional sprays during the bloom period if weather remains favourable for blight.</p> <p>To avoid resistance, do not apply Topas/Mission, Nova, Rovral, Elevate, Indar or Lance more than two times for each product per season. Alternate between fungicide families and do not use the same product in consecutive sprays. See <i>Pest Resistance to Insecticides, Fungicides, Miticides</i>, on page 13, and Table 7-7. <i>Products Used on Sweet Cherries</i>, on page 159.</p> <p>Nova and Topas/Mission: Are absorbed by flower parts, making these materials more rainfast than other protectant fungicides.</p> <p>Captan, Maestro or Bravo: Do not use within 14 days of an application of Superior Oil.</p> <p>Bravo: Do not apply after shuck to avoid fruit injury.</p> <p>Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.</p> <p>Topas/Mission and Indar: Are from the same chemical family. Do not alternate Topas/Mission and Indar.</p>
Petal fall			
Black cherry aphid	<ul style="list-style-type: none"> Diazinon 50 W Thiodan 50 WP or Thionex 50 W Zolone Flo 	3.00 kg 4.50 kg 4.50 kg 2.00 L	<p>A temperature of at least 21°C, thorough coverage and a calm day are needed for effective aphid control. Usually one to two sprays are required.</p> <p>Zolone: Maximum three applications per season.</p>
Shuck fall			
Plum curculio	<ul style="list-style-type: none"> Guthion 50 WSB or Sniper Zolone Flo 	see label see label 2.00 L	<p>Spray when most of the shucks are off and plum curculio activity is observed, usually when temperatures are above 16°C.</p> <p>Zolone: Also helps control aphids. Maximum three applications of Zolone per season.</p>
Brown rot	<ul style="list-style-type: none"> Topas 250 E or Mission 418 EC Rovral Supra Captan 80 WDG or Maestro 80 DF Elevate 50 WDG Lance WDG Indar 75 WSP Pristine WG 	500 mL 300 mL 1.75 kg 4.50 kg 4.50 kg 1.70 kg 370 g 140 g 750 g	<p>Captan and Maestro: May cause leaf injury to Schmidt and Emperor Francis varieties in postbloom sprays.</p> <p>To avoid resistance, do not apply Topas/Mission, Nova, Rovral, Elevate, Indar or Lance more than two times for each product per season. Alternate between fungicide families and do not use the same product in consecutive sprays.</p> <p>Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.</p>
First cover (12 days after Shuck fall)			
Plum curculio	Use one of the insecticides listed under Shuck fall .		<p>Zolone: Helps control aphids but is only fair against plum curculio. Monitor 7 days after shuck fall insecticide for new plum curculio damage. Apply insecticide if new crescent-shaped cuts are found.</p>

Diseases and Insects	Materials	Amount/ha	Comments
Brown rot	Use one of the fungicides listed under Shuck fall .		
Second cover (12 days after first cover)			
Cherry fruit fly	<ul style="list-style-type: none">• Diazinon 50 W• Zolone Flo• GF-120 NF or Entrust 80 W• Guthion 50 WSB or Sniper	<ul style="list-style-type: none">3.00 kg2.00 L1.50 L109 gsee labelsee label	<p>GF-120 NF: Spray as soon as monitoring traps indicate flies are present or 2–3 weeks before ripening. GF-120 is a bait formulation that requires large droplet size (4–6 mm); specialized application equipment may be needed. GF-120 will lose effectiveness if exposed to rain or overhead irrigation.</p> <p>Diazinon, Zolone and Guthion: On early varieties, check the preharvest interval. Spray when early varieties are beginning to colour.</p> <p>Diazinon: Provides 10 days protection against cherry fruit fly.</p> <p>Zolone: Provides 12–14 days protection against cherry fruit fly. Maximum three applications of Zolone per season.</p>
Plum curculio	<ul style="list-style-type: none">• Guthion 50 WSB or Sniper• Zolone Flo	<ul style="list-style-type: none">see labelsee label2.00 L	<p>Zolone: Helps control aphids but is only fair against plum curculio. Monitor 7 days after previous insecticide for new plum curculio damage. Apply insecticide if new crescent-shaped cuts are found.</p>
Powdery mildew	<ul style="list-style-type: none">• Cabrio EG• Pristine WG	<ul style="list-style-type: none">670 g750 g	<p>Powdery mildew is not a common problem on sweet cherries. Only required on susceptible varieties.</p> <p>Pristine and Cabrio: Include active ingredients in the same fungicide family. Do not alternate Pristine with Cabrio.</p> <p>Pristine: Provides suppression of powdery mildew.</p>
Brown rot	<ul style="list-style-type: none">• Topas 250 E or Mission 418 EC• Rovral• Supra Captan 80 WDG or Maestro 80 DF• Elevate 50 WDG• Lance WDG• Indar 75 WSP• Pristine WG	<ul style="list-style-type: none">500 mL300 mL1.75 kg4.50 kg4.50 kg1.70 kg370 g140 g750 g	<p>To avoid resistance, do not apply Topas/Mission, Nova, Rovral, Elevate, Indar or Lance more than two times for each product per season. Alternate between fungicide families and do not use the same product in consecutive sprays.</p> <p>Topas/Mission: Apply no more than two applications of Topas/Mission in the 3 weeks prior to harvest.</p> <p>Captan and Maestro: May cause leaf injury to Schmidt and Emperor Francis varieties in postbloom sprays.</p> <p>Pristine and Lance: Include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.</p>
Third cover			
Cherry fruit fly	<ul style="list-style-type: none">• Diazinon 50 W• Zolone Flo• GF-120 NF or Entrust 80 W• Sevin XLR	<ul style="list-style-type: none">3.00 kg2.75 L1.50 L109 g6.25 L	<p>Check preharvest interval before spraying early maturing cherries. See Table 7-7, <i>Products Used on Sweet Cherries</i>, on page 159.</p> <p>GF-120: Spray as soon as monitoring traps indicate flies are present or 2–3 weeks before ripening. GF-120 is a bait formulation that requires large droplet size (4–6 mm); specialized application equipment may be needed. GF-120 will lose effectiveness if exposed to rain or overhead irrigation.</p> <p>Sevin XLR: Provides 5–7 days protection.</p> <p>Zolone: Maximum three applications per season.</p>
Brown rot	Use one of the fungicides listed under Second cover .		
Prepick			
Brown rot	<ul style="list-style-type: none">• Rovral• Supra Captan 80 WDG or Maestro 80 DF• Elevate 50 WDG• Lance WDG• Indar 75 WSP• Topas 250 E or Mission 418 EC• Pristine WG	<ul style="list-style-type: none">1.75 kg4.50 kg4.50 kg1.70 kg370 g140 g500 mL300 mL750 g	<p>Consult product labels for preharvest intervals in Table 7-7, <i>Products Used on Sweet Cherries</i>, on page 159.</p> <p>To avoid resistance, do not apply Topas/Mission, Nova, Rovral, Elevate, Indar, or Lance more than two times for each product per season. Alternate between fungicide families and do not use the same product in consecutive sprays.</p> <p>Captan and Maestro: May cause leaf injury to Schmidt and Emperor Francis varieties in postbloom sprays.</p> <p>Pristine and Lance: Include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.</p>

Diseases and Insects	Materials	Amount/ha	Comments
Postharvest orchard treatment			
Leaf spot	<ul style="list-style-type: none"> • Equal 65 WP • Supra Captan 80 WDG or Maestro 80 DF • Ferbam 76 WDG • Pristine WG 	2.25 kg 4.50 kg 4.50 kg see label 750 g	Only necessary where leaf spot is a problem or where sweet cherries are beside sour cherries. Captan and Maestro: May cause leaf injury to the Schmidt and Emperor Francis varieties in postbloom sprays.
Special sprays (when monitoring indicates the need)			
Obliquebanded leafroller	<ul style="list-style-type: none"> • Dipel 2X DF or Bioprotec CAF • Success 480 SC or Entrust 80 W 	1.12 kg 4.00 L 182 mL 109 g	Routine monitoring is necessary to determine if obliquebanded leafrollers are causing damage in sweet cherries.
Postharvest fruit treatment			
Blue mould, grey mould, brown rot, rhizopus rot	<ul style="list-style-type: none"> • Scholar 50 WP 	227 g/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions.

TABLE 7-7. Products Used on Sweet Cherries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Bioprotec CAF	<i>Bacillus thuringiensis</i>	B.t. microbial	1		
Bravo 500	chlorothalonil	chloronitrile	40	48 hours	3 preharvest
Cabrio EC	pyraclostrobin	strobilurin	10	10 days for hand labour	5
Diazinon 50 W	diazinon	organophosphate	10		
Dipel 2X DF	<i>Bacillus thuringiensis</i>	B.t. microbial	1		
Elevate 50 WDG	fenhexamid	hydroxyaniline	1	4 hours	4
Entrust 80 W	spinosad	naturolite	7		3
Equal	dodine	guanidine	7		
Ferbam 76 WDG	ferbam	dithiocarbamate	4		
Funginex DC	triforine	piperazine	do not use after bloom		3
GF-120 NF	spinosad	naturolite/spinosyns	0		10
Guthion 50 WSB	azinphosmethyl	organophosphate	15	15 days	2
Indar 75 WSP	fenbuconazole	triazole (DMI)	1	12 hours	7
Lance WDG	boscalid	anilide carboxamide	0	4 hours	5
Maestro 80 DF	captan	phthalimide	2	48 hours	
Mission 418 EC	propiconazole	triazole (DMI)	3	72 hours	5*
Nova 40 W	myclobutanil	triazole (DMI)	1		

* No more than two applications in the 3 weeks prior to harvest.

TABLE 7-7. Products Used on Sweet Cherries (cont'd)

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Pristine WG	boscalid + pyraclostrobin	anilide carboxamide + QoI	0	24 hours for hand harvest, 10 days for hand thinning	5
Rovral	iprodione	dicarboximide	1	12 hours	
Scholar 50 WP	fludioxonil	phenylpyrrole	postharvest		
Sevin XLR	carbaryl	carbamate	2		
Sniper	azinphosmethyl	organophosphate	15	15 days	2
Success 480 SC	spinosad	naturolyte/spinosyn	7		3
Supra Captan 80 WDG	captan	phthalimide	2	48 hours	
Thiodan 50 WP	endosulfan	chlorinated cyclodiene	15		2
Thionex 50 W	endosulfan	chlorinated cyclodiene	15		2
Topas 250 E	propiconazole	triazole (DMI)	3	72 hours	5*
Zolone Flo	phosalone	organophosphate	14	24 hours	3

* No more than two applications in the 3 weeks prior to harvest.

Growth Regulators for Sweet Cherries

To delay ripening and improve fruit quality of sweet cherries

Research in British Columbia shows that gibberellic acid (GA) delays fruit ripening 4–5 days and thus extends the picking period, which may delay the susceptibility to rain cracks. The treatment also increases fruit size, firmness and resistance to post-harvest disorders.

- Dissolve 20 Falgro® tablets in 1,000 L of water to produce a 20 ppm solution and apply as a foliar spray to run off.
- Apply 21 days before normal harvest when the fruit is at the straw coloured stage.
- Harvest when fruits are at the desired shade of red but not within 21 days after spraying.

See also *Using GA to encourage vegetative growth in cherry trees*, on page 156.

Peach Calendar

Read the label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For resistance management, refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, on page 13.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-8. *Products Used on Peaches*, on page 165.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant (in March or early April before buds swell)			
Leaf curl	<ul style="list-style-type: none"> Ferbam 76 WDG Bravo 500 	see label 7.00 L	Delay may result in poor control of leaf curl. Ferbam: If mixing with oil, follow mixing directions on the Superior 70 Oil label carefully or poor leaf curl control will result. Bravo: Do not apply within 10 days of an oil application because it will burn flower and leaf tissue.
(Leaf curl spray is not needed in spring if a spray was applied last fall)			
San Jose scale	<ul style="list-style-type: none"> Superior 70 Oil 	20 L/1,000 L water	Apply oil routinely every third year. If scale is a serious or continuing problem, apply oil for at least two consecutive years.
Prebloom (half-inch green to first pink)			
European red mite	<ul style="list-style-type: none"> Superior 70 Oil 	20 L/1,000 L water	Preferred time to use oil for red mite control if overwintering populations are high. Red mite populations are more likely to be high if pyrethroid sprays were used the previous year for oriental fruit moth and tarnished plant bug control.
Oriental fruit moth	<ul style="list-style-type: none"> Isomate-M Rosso Isomate-M100 	500 dispensers/ha 250 dispensers/ha	Pheromone mating disruption products are not insecticides and will not control other pests that may be present. Initial OFM population must be low. Apply to square or rectangular orchard blocks at least 4 ha in size. Must be applied before moth flight begins. For more information on mating disruption refer to OMAFRA Factsheets, <i>Mating Disruption for Management of Insect Pests</i> , Order No. 03-079 and <i>Mating Disruption for Management of Oriental Fruit Moth in Stone and Pome Fruit</i> , Order No. 04-029. Isomate-M 100: Make a second application 75–80 days after initial application. Isomate-M Rosso: Provides mating disruption for up to 120 days. If desired, use both an insecticide and mating disruption for managing first generation OFM (see Shuck split).

Diseases and Insects	Materials	Amount/ha	Comments
Pink through bloom			
Blossom blight stage of brown rot	<ul style="list-style-type: none"> • Topas 250 E or Mission 418 EC • Nova 40 W • Bravo 500 • Supra Captan 80 WDG or Maestro 80 DF • Funginex DC • Rovral • Vangard 75 WG • Microscopic Sulphur • Elevate 50 WDG • Lance WDG • Indar 75 WSP • Pristine WG 	500 mL 300 mL 340 g 7.00 L 4.50 kg 4.50 kg 2.50 L 1.50 kg 370 g see label 1.70 kg 370 g 140 g 750 g	Spray when first blossoms are opening (late pink). Repeat every 4–5 days if weather is wet. To avoid resistance, alternate between fungicide families. Do not use Nova, Topas/Mission, Rovral, Elevate, Lance, Indar, Funginex or Vangard more than two times for each product per season and never in consecutive sprays. Sulphur: May encourage mite build-up. Bravo, Captan or Maestro: Do not apply within 10 days of an oil application, because this causes burning of flower and leaf tissue. Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.
Petal fall and shuck spray			
Green peach aphid	<ul style="list-style-type: none"> • Admire 240 	230 mL	Thresholds for application are 30% of terminals infested or 20 colonies per tree for peaches and 10% of terminals infested or 5–10 colonies per tree for nectarines.
First generation oriental fruit moth spray: Shuck split			
Oriental fruit moth	<ul style="list-style-type: none"> • Lorsban 50 W 	3.50 kg	Where mating disruption products for OFM have been placed in the orchard, a pesticide application is generally not required at this time. Lorsban: Use for the control of first generation and use pyrethroids for generations two through four to provide rotation of insecticide families and avoid rapid selection of resistance to the pyrethroid insecticides. Do not use pyrethroids for control of first generation OFM.
Plum curculio	<ul style="list-style-type: none"> • Guthion 50 WSB or Sniper 	see label see label	Plum curculio is a sporadic pest of peaches and nectarines. Scout edges of orchards near woodlots and wild hosts in spring. Check small fruit for crescent-shaped egg laying scars. A border spray of 4–6 rows may provide sufficient control. Check developing fruit for new damage 7–10 days later.
Brown rot	<ul style="list-style-type: none"> • Topas 250 E or Mission 418 EC • Rovral • Supra Captan 80 WDG or Maestro 80 DF • Microscopic Sulphur • Vangard 75 WG • Elevate 50 WDG • Lance WDG • Indar 75 WSP • Pristine WG 	500 mL 300 mL 1.50 kg 4.50 kg 4.50 kg see label 740 g 1.70 kg 370 g 140 g 750 g	Alternate between fungicide families. Do not use Rovral, Topas/Mission, Elevate, Lance, Indar or Vangard more than two times for each product per season and never in consecutive sprays. Spray again in 7 days if wet weather persists. Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.

Diseases and Insects	Materials	Amount/ha	Comments
European red mite	<ul style="list-style-type: none"> • Apollo SC • Kelthane 50 W 	300 mL 3.25 kg	<p>If oil was applied in the spring, a miticide is likely not necessary at this time.</p> <p>Apollo: Most effective on eggs and newly hatched nymphs. Apply when leaf tissue is present, mites are mostly in the first summer generation egg stage and before there are three active mites per leaf. Use sufficient water volumes to obtain good coverage, but not less than 475 L/ha. Apply up to 14 days after petal fall.</p> <p>Kelthane: Most effective on mite nymphs. Check leaves and apply if 5–7 active red mites per leaf are present and there are few beneficial predatory mites. Kelthane is a slow-acting material, so wait 7–10 days after use to evaluate results. Repeated use of Kelthane has led to red mite resistance.</p>
Lesser peachtree borer Peachtree borer	<ul style="list-style-type: none"> • Thiodan 50 WP or Thionex 50 W • Thiodan 4 EC • Sevin XLR 	1.50 kg/1,000 L 1.50 kg/1,000 L 1.75 L/1,000 L 6.25 L	<p>Peachtree borers are sporadic pests. Spray in areas with high borer populations. Use pheromone traps to monitor adult activity and begin sprays one week after first flight. Make three applications at 5–10 day intervals. Direct these sprays with a handgun to cover trunk and scaffold limbs thoroughly; do not spray fruit. Check the days to harvest interval. Do not apply second Thiodan spray to varieties in the Harrow Diamond and Garnet Beauty season; on these varieties use Sevin XLR. Do not use third Thiodan spray on varieties in the Sunhaven, Redhaven, Veecling and Vivid season; on these varieties use Sevin XLR.</p>
Special sprays (when monitoring indicates the need during early green fruit stage to pit hardening)			
Tarnished plant bug	<ul style="list-style-type: none"> • Matador 120 EC • Ripcord 400 EC • Thiodan 50 WP or Thionex 50 W 	104 mL 175 mL 4.50 kg 4.50 kg	<p>General timing is mid-June if 2% or more fruit damage is observed. However, plant bugs usually are adequately controlled by the second generation oriental fruit moth spray. Where plant bug pressure is high and significant new damage is detected, repeat spray in 5–7 days.</p> <p>Plant bug pressure is lower in orchards with managed sod. Other cultural techniques can reduce damage from this pest.</p> <p>Ripcord: Also controls oak plant bug.</p>
Second generation oriental fruit moth spray			
Oriental fruit moth	<ul style="list-style-type: none"> • Decis 5 EC • Ripcord 400 EC • Pounce • Matador 120 EC 	200 mL 175 mL 275 mL 104 mL	<p>Spray all varieties. This generation may require two insecticide sprays applied about 14 days apart.</p> <p>If mating disruption for OFM is being used a pesticide application is not required for second generation OFM.</p> <p>Decis: Maximum one application per year.</p>
Brown rot (early varieties only – Harrow Diamond through Sunhaven)	<ul style="list-style-type: none"> • Topas 250 E or Mission 418 EC • Supra Captan 80 WDG or Maestro 80 DF • Rovral • Microscopic sulphur • Vangard 75 WG • Elevate 50 WDG • Lance WDG • Indar 75 WSP • Pristine WG 	500 mL 300 mL 4.50 kg 4.50 kg 1.50 kg see label 740 g 1.70 kg 370 g 140 g 750 g	<p>Sulphur: May induce mite problems.</p> <p>Topas/Mission: Maximum two applications in the 3 weeks prior to harvest.</p> <p>Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.</p>

Diseases and Insects	Materials	Amount/ha	Comments
Special sprays (when monitoring indicates the need)			
European red mite	• Pyramite or Nexter	300 g	Check product labels for preharvest intervals in Table 7-8. <i>Products Used on Peaches</i> , on page 165. Apply this spray around the second oriental fruit moth spray (early July) if needed. On cultivars Harbrite and later, examine for mites again 3 weeks before harvest. Spray if 5–10 active pest mites per leaf are present in July and few beneficial mites are present. Monitor carefully because populations of pest mites can build rapidly. Pyramite/Nexter: Most effective when applied to mite nymphs. Use 600 g/ha for two-spotted spider mites. Envidor: Effective against all life stages of pest mites but fastest activity will be achieved if application is made early when the majority of mites are in the nymphal stages. Miticides are best used alone. Use a minimum water volume of 1,000 L/ha for effective control.
Two-spotted spider mite	• Envidor 240 SC	300 g	
	• Carzol SP	750 mL	
	• Kelthane 50 W	1.10 kg	
		3.25 kg	
Third generation oriental fruit moth spray (late varieties)			
Oriental fruit moth	• Decis 5 EC	200 mL	Usually for all varieties from Vivid season and later. If mating disruption for OFM is being used a pesticide application is not required for third generation OFM. Decis: Maximum one application per year.
	• Ripcord 400 EC	175 mL	
	• Pounce	275 mL	
Brown rot	• Topas 250 E or Mission 418 EC	500 mL	Sulphur: May induce mite problems. Topas/Mission: Maximum two applications in the 3 weeks prior to harvest. Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.
	• Supra Captan 80 WDG or Maestro 80 DF	300 mL	
	• Rovral	4.50 kg	
	• Microscopic sulphur	1.50 kg	
	• Vanguard 75 WG	see label	
	• Elevate 50 WDG	740 g	
	• Lance WDG	1.70 kg	
	• Indar 75 WSP	370 g	
	• Pristine WC	140 g	
		750 g	
Prepick spray			
Oriental fruit moth	• Decis 5 EC	200 mL	Spray each variety 7–10 days before first harvest when first colour shows. See comments on organophosphate resistance under <i>First oriental fruit moth spray</i> , on page 162. If mating disruption is being used for OFM a prepick spray is not necessary unless local populations have historically been high or in cases where late season peaches are the only remaining fruit in an area. Decis: Maximum one application per year.
	• Ripcord 400 EC	175 mL	
	• Pounce	275 mL	
Brown rot	• Topas 250 E or Mission 418 EC	500 mL	Apply with OFM sprays 7–10 days before harvest. Sulphur: Use may induce mite problems. Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance. Topas/Mission and Indar: From the same chemical family. Do not alternate Topas/Mission and Indar.
	• Supra Captan 80 WDG or Maestro 80 DF	300 mL	
	• Rovral	4.50 kg	
	• Microscopic sulphur	1.50 kg	
	• Vanguard 75 WG	see label	
	• Elevate 50 WDG	740 g	
	• Lance WDG	1.70 kg	
	• Indar 75 WSP	370 g	
	• Pristine WC	140 g	
		750 g	
Rhizopus rot	• Botran 75 W	see label	

Diseases and Insects	Materials	Amount/ha	Comments
Postharvest fruit treatment			
Blue mould, grey mould, brown rot, rhizopus rot	• Scholar 50 WP	227 g/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions.
Fall spray (preferred time to spray for leaf curl)			
Leaf curl	• Ferbam 76 WDG • Bravo 500	see label 7.00 L	Apply any time after leaves are off in fall or winter when temperature in shade is above freezing and conditions favour rapid drying.

TABLE 7-8. Products Used on Peaches

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Admire 240	imidacloprid	neonicotinoid	7	24 hours	2
Apollo SC	clofentezine	tetrazine	apply no later than 14 days after petal fall		1
Botran 75 W	dicloran	chlorophenyl	10		2
Bravo 500	chlorothalonil	chloronitrile	60	48 hours	4
Carzol SP	formetanate hydrochloride	carbamate	21		1
Decis 5 EC	deltamethrin	pyrethroid	1		1
Elevate 50 WDG	fenhexamid	hydroxylaniline	1	4 hours	4
Envidor 240 SC	spirodiclofen	tetronic acid derivative	7	12 hours	1
Ferbam 76 WDG	ferbam	dithiocarbamate	21		
Funginex DC	triforine	piperazine	do not apply after bloom		3
Guthion 50 WSB	azinphosmethyl	organophosphate	21	14 days	2
Indar 75 WSP	fenbuconazole	triazole (DMI)	1	12 hours	7
Kelthane 50 W	dicofol	diphenylethane	14		1
Lance WDG	boscalid	anilide carboxamide	0	4 hours	5
Lorsban 50 W	chlorpyrifos	organophosphate	21	4 days	2
Maestro 80 DF	captan	phthalimide	2	48 hours	
Matador 120 EC	cyhalothrin lambda	pyrethroid	7	24 hours	3
Microscopic Sulphur	sulphur	inorganic	1		
Mission 418 EC	propiconazole	triazole (DMI)	3	72 hours	5*
Nexter	pyridaben	pyridazinone	14	24 hours	1
Nova 40 W	myclobutanil	triazole (DMI)	1		6
Pounce	permethrin	pyrethroid	7		

* No more than two applications in the 3 weeks prior to harvest.

TABLE 7-8. Products Used on Peaches (cont'd)

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Pristine WG	boscalid + pyraclostrobin	anilide carboxamide + QoI	0	24 hours for hand harvest, 10 days for hand thinning	5
Pyramite	pyridaben	pyridazinone	14	24 hours	1
Ripcord 400 EC	cypermethrin	pyrethroid	7		2
Rovral	iprodione	dicarboximide	1	12 hours	
Scholar 50 WP	fludioxonil	phenylpyrrole	postharvest		
Sevin XLR	carbaryl	carbamate	1		
Sniper	azinphosmethyl	organophosphate	21	14 days	2
Superior 70 Oil	mineral oil		apply prebloom		
Supra Captan 80 WDG	captan	phthalimide	2	48 hours	
Thiodan 4 EC	endosulfan	chlorinated cyclodiene	15		3
Thiodan 50 WP	endosulfan	chlorinated cyclodiene	15		3
Thionex 50 W	endosulfan	chlorinated cyclodiene	15		3
Topas 250 E	propiconazole	triazole (DMI)	3	72 hours	5*
Vanguard 75 WG	cyprodinil	anilinopyrimidine	2	72 hours	4

* No more than two applications in the 3 weeks prior to harvest.

Thinning Peaches

Peach thinning is an essential orchard management practice. Thinning is necessary to obtain good-sized, quality fruit and to reduce problems associated with over-cropping. These problems include limb breakage, reduced fruit size and quality, loss of tree vigour, shortened orchard life and increased pest management problems.

When thinning, consider fruit load as well as fruit spacing. Optimum fruit load depends on cultivar, tree vigour, tree age and health, and orchard management practices such as tree spacing, irrigation and pruning. Peach growers tend to think of spacing the fruit 15–20 cm apart. However, distance between fruit is less critical as long as clusters are broken up and fruit is separated. Tree crop load (kg per tree or number of fruit per tree) is a more important consideration. As an example, a yield of 18–27 tonnes/ha (8–12 tons/acre) in an orchard with a tree density of 490 trees per ha (200 trees per acre) requires about 200–300 fruit per tree, if you assume an average fruit size of 4–7 fruit per kg (2–3 fruit per lb). With current emphasis on increased fruit size for better marketability and trends towards higher tree densities, fruit loads of 175–200 fruit per tree may be more ideal, at least for cultivars that normally produce large fruit.

Factors to consider when thinning peaches

Timing — Start thinning near the end of June drop (about mid-June) when it can be determined which fruits will abort and fall on their own. Thinning at early fruit development or even blossom time is more beneficial than late thinning. However, it is difficult to get a true assessment of crop load before June drop occurs. Thin early-ripening cultivars first in order to obtain proper fruit size. In some years, a follow-up hand thinning may be necessary.

Pruning — Pruning is an essential part of the fruit-thinning procedure. Pruning selectively removes fruit-bearing surface, as well as some of the excess crop. Normal fruit thinning must follow to avoid over-cropping.

Cultivars — Cultivar selection over the years has tended towards larger fruit. Earlier ripening cultivars have a high percentage of fruit with split pits. Some growers thin early cultivars twice; thinning lightly to remove some crop load, then a second time to selectively remove split-pit fruit. Harrow Diamond is the earliest commercial-ripening cultivar with few split-pit fruit. This cultivar must be well thinned to obtain suitable size. There is little likelihood of over-thinning early cultivars when the set is heavy. Heavy-setting, hard-to-size cultivars

such as Redhaven require heavier thinning than easier-to-size types like Vivid and Loring. As a rule of thumb, however, late maturing cultivars with a good, uniform set are thinned 10–13 cm apart in order to produce good-sized fruit. Cultivars are different and are thinned according to their individual requirements.

Irrigation —Irrigation is recommended to enhance fruit size, especially in long periods of dry conditions. There are two key periods to irrigate peaches; during cell division (from bloom to 30 days after bloom) and during cell expansion (approximately 2–4 weeks before harvest). Start irrigation early in the season and continue a regular schedule based on the amount of rainfall, rate of evapotranspiration and soil holding capacity. Permanent orchard sod is very competitive and additional irrigation might be needed to compensate for soil moisture loss. Adjust irrigation schedule based on additional factors such as crop load, winter injury, insect, disease or other stress factors. New technology is being developed for commercial growers to closely monitor soil moisture. Orchards without irrigation may, in some years, need a second thinning during July to attain marketable fruit size.

Thinning methods — Thinning is most commonly accomplished by hand with manual labour. Large

quantities of fruit can be removed in a hurry with physical aids such as a child's plastic bat, a rubber hose mounted on a bamboo pole or broom handle, or a plastic rake manufactured for this purpose. Follow this initial thinning with "touch-up" thinning a few days later to assure that fruit numbers per tree produce good-sized fruit for the cultivar and orchard condition. Ensure clusters are broken up and fruit separated. If the set is spotty on the tree, more fruit may be left on the heavy-set branches.

Other methods that have been investigated are:

- **Mechanical trunk shaker** – This method of shaking fruit when they are walnut-size is erratic and can result in over-thinning. The negative, long-term effect on the root system has yet to be determined.
- **Rope thinning during bloom and 4–6 weeks after bloom** – Tree training systems need to be properly developed to adapt rope thinning. Moderate success has been achieved in some research and grower trials.
- **Chemical thinning** – No chemicals are registered for fruit thinning peaches in Ontario.

Any of the above methods must be supplemented by touch-up hand thinning.

Pear Calendar

Read the label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For resistance management, refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, on page 13.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-9. *Products Used on Pears*, on page 172.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant			
Scale insects Pear psylla	• Superior 70 Oil	20 L/1,000 L water	Use 2,000–3,000 L of water/ha. Good coverage is essential. Do not apply full rate of oil more than once per season.
Green tip			
Scab	<ul style="list-style-type: none"> • Equal 65 WP • Supra Captan 80 WDG or Maestro 80 DF • Dikar • Flint 50 WG • Sovran • Scala SC 	3.25 kg 3.75 kg 3.75 kg 6.75 kg 140 g 240 g 1.00 L	Start scab control early and repeat the spray if weather remains wet. Captan or Maestro: Do not use on d'Anjou pears. Dikar: If used at 10 day intervals, controls pear scab and pear psylla nymphs. It also suppresses European red mite and rust mite populations. Do not use Dikar within 45 days of harvest. Higher water volumes aid in mite suppression. Sovran or Flint: Apply up to two sequential sprays, followed by two or more applications of a fungicide with a different mode of action. Where disease pressure is high, use up to 360 g/ha of Sovran. Maximum four applications Sovran or Flint per season. Scala: Do not use within 72 days of harvest.
European red mite Pear psylla	• Superior 70 Oil	20 L/1,000 L water	Best applied at or near Green tip for mites. Use 2,000–3,000 L of water per ha. Good coverage is essential. Oil does not control rust mite. Do not apply full rate of oil more than once per season. Do not use Captan or Maestro within 14 days of an application of Superior Oil.
Pear psylla	• Surround WP	50.0 kg	Begin spray program before overwintering adults are active. Make two applications at 50 kg/ha, 7 days apart, to establish a base layer. Continue applications at 7–14 day intervals. Surround may interfere with optimum bee activity. Do not apply Surround during the green cluster bud to petal fall stage. See <i>Particle film technology</i> , on page 10.
Oriental fruit moth	<ul style="list-style-type: none"> • Isomate-M Rosso • Isomate-M 100 	500 dispensers/ha 250 dispensers/ha	Pheromone mating disruption products will not control other pests that may be present in the orchard. Initial OFM population must be low. Use in square or rectangular orchard blocks at least 4 ha in size. Apply before moth flight begins. For more information on mating disruption refer to OMAFRA Factsheets, <i>Mating Disruption for Management of Insect Pests</i> , Order No. 03-079 and <i>Mating Disruption for Management of Oriental Fruit Moth in Stone and Pome Fruit</i> , Order No. 04-029. Isomate-M 100: Make a second application 75–80 days after the first. Isomate-M Rosso: Provides mating disruption for up to 120 days. In crops with long field seasons, make a second application. If desired, use both an insecticide and mating disruption for managing first generation OFM (see Petal fall).

Diseases and Insects	Materials	Amount/ha	Comments
Prebloom (as blossoms show white at tips)			
Scab	Use one of the materials listed for scab control under Green tip . Repeat spray if weather remains wet.		
Rust mite	• Carzol SP	1.10 kg	Carzol: Harsh on beneficial mites and honeybees. Kelthane: If Kelthane has been used for four or more years, choose a different product, because resistant mites are likely present. Kanemite: Is not effective on rust mites.
European red mite	• Kelthane 50 W	3.25 kg	
	• Kanemite 15 SC	2.10 L	
Pear psylla	• Assail 70 WP • Thiodan 50 WP or Thionex 50 W • Guthion 50 WSB or Sniper • Pyramite or Nexter	120 g 6.75 kg 6.75 kg see label see label 600 g 600 g	To avoid resistance problems, pyrethroids are not recommended at this time. Refer to comments at First cover . Guthion or Sniper: Also controls green fruitworm. Maximum three applications per season. Pyramite/Nexter: Maximum two applications per season. Assail: Maximum four applications per season. Thiodan or Thionex: Maximum two applications after calyx.
Plant bugs	• Thiodan 50 WP or Thionex 50 W	4.50 kg 4.50 kg	Also helps control psylla.
Bloom			
There are special pollination requirements for pears. See Pollination Requirements for Fruit Crops, at ontario.ca/crops			
DO NOT APPLY INSECTICIDES WHILE PEARS ARE IN BLOOM. SEE BEE POISONING ON PAGE 192.			
Fire blight	• Streptomycin 17	600 g/1,000 L	Sprays are most effective when applied dilute (high volumes of water) prior to a wetting period. Use alone for best results. Because Streptomycin 17 is UV light sensitive it is only effective for 2–3 days. If warm wet conditions (above 20°C) prevail, two to three sprays during bloom may be required for fire blight control. To avoid resistance use a maximum of three sprays per season. For more information, refer to OMAFRA Factsheet, <i>Fire Blight of Apple and Pear in Ontario</i> , Order No. 02-011.
Petal fall			
Plum curculio	• Actara 25 WG • Calypso 480 SC • Guthion 50 WSB or Sniper	385 g 440 mL see label see label	Actara: Do not apply when bees are in the orchard. After an Actara application, wait at least 5 days before placing bee hives in the orchard. Calypso: Research indicates that application of Calypso at petal fall plus 3 days is the optimal timing for PC. However, if monitoring indicates PC is in the orchard prior to this timing, then insecticides should be applied at petal fall.

Diseases and Insects	Materials	Amount/ha	Comments
Pear psylla	<ul style="list-style-type: none"> • Agri-Mek 1.9% EC • Assail 70 WP • Actara 25 WG • Surround WP • Thiodan 50 WP or Thionex 50 W • Guthion 50 WSB or Sniper • Pyramite or Nexter 	1.00 L 120 g 385 g 50.00 kg 6.75 kg 6.75 kg see label 600 g 600 g	<p>Agri-Mek: Do not use within 14 days of a Captan or Maestro application. Apply no later than 21 days after petal fall for best results. Apply Agri-Mek with 10 L superior oil and a minimum of 1,000 L of water per ha, when most mites are in the nymphal stage. May cause russetting to d'Anjou and other sensitive varieties. Maximum one application per season. Alternate yearly with other insecticides. Agri-Mek will not control plum curculio.</p> <p>Guthion or Sniper: Maximum three applications per season.</p> <p>Pyramite/Nexter: Maximum two applications per season.</p> <p>Assail: Maximum four applications per season.</p> <p>Thiodan or Thionex: Maximum two applications after calyx.</p> <p>Surround: May interfere with optimum bee activity. Do not apply during the green cluster bud to petal fall stage. See <i>Particle film technology</i>, on page 10.</p> <p>Actara: Do not apply when bees are in the orchard. After an Actara application, wait at least 5 days before placing beehives in the orchard.</p>
Obliquebanded leafroller Green fruitworm	<ul style="list-style-type: none"> • Dipel 2X DF or Foray 48BA or Bioprotec CAF • Success 480 SC or Entrust 80 W • Intrepid 240 F • Imidan 50 WP • Guthion 50 WSB or Sniper 	1.12 kg 2.80 L 4.00 L 182 mL 109 g 750 mL 3.75 kg see label see label	<p>B.t. products (Dipel, Foray and Bioprotec): Are most effective when larvae are actively feeding and weather is warm and dry for 3 days after application. For B.t. products, make two to three applications to cover the extended emergence of overwintering larvae. B.t. products work best if applied in the evening or on a cloudy day.</p>
Rust mite European red mite	<ul style="list-style-type: none"> • Carzol SP • Kelthane 50 W • Envidor 240 SC • Kanemite 15 SC 	1.10 kg 3.25 kg 750 mL 2.10 L	<p>To control rust mite and prevent russeted fruit, apply a miticide at prebloom or petal fall. Alternate miticides.</p> <p>Carzol: Is harsh on beneficial mites and honeybees.</p> <p>Kelthane: If Kelthane has been used for four or more years, choose a different product, because resistant mites are likely present.</p> <p>Kanemite: Is not effective on rust mites.</p>
Leaf spots Scab	Use one of the fungicides listed for scab at Green tip .		If wet weather persists, additional sprays will be needed for scab control before first cover. Where there is a problem, spray at petal fall and first cover. A dilute spray is necessary for good control.
Special spray (when monitoring indicates the need at Petal fall)			
Codling moth	<ul style="list-style-type: none"> • Imidan 50 WP • Assail 70 WP • Calypso 480 SC • Guthion 50 WSB or Sniper 	3.75 kg 170 g 440 mL see label see label	For sites with a history of codling moth damage, apply one of these insecticides. Codling moth might be a problem if pear plantings are located near wild apple, pear and other hosts infested with codling moth. Use codling moth timing as recommended for apple.

Diseases and Insects	Materials	Amount/ha	Comments
First cover			
Pear psylla	<ul style="list-style-type: none">• Thiodan 50 WP or Thionex 50 W• Assail 70 WP• Actara 25 WG• Surround WP• Decis 5 EC• Ripcord 400 EC• Pounce• Matador 120 EC• Agri-Mek 1.9% EC• Pyramite or Nexter• Guthion 50 WSB or Sniper	<div>6.75 kg</div> <div>6.75 kg</div> <div>120 g</div> <div>385 g</div> <div>50.00 kg</div> <div>350 mL</div> <div>175 mL</div> <div>520 mL</div> <div>83 mL</div> <div>1.00 L</div> <div>600 g</div> <div>600 g</div> <div>see label</div> <div>see label</div>	<p>Apply when the majority of the population is in early instar stages.</p> <p>Where plum curculio is a later season problem, use one of the materials recommended at Petal fall.</p> <p>Decis, Ripcord, Pounce, Matador: Resistance to these pyrethroid insecticides was recorded as widespread in the past. Resistance to these products may still be present.</p> <p>Agri-Mek: Apply no later than 21 days after petal fall. Apply with 10 L Superior Oil and a minimum of 1,000 L of water per ha. Apply when most mites are in the nymphal stage. May cause russetting to d'Anjou and other sensitive varieties. Do not use oil within 14 days of a Captan or Maestro application.</p> <p>Surround: See <i>Particle film technology</i>, on page 10.</p> <p>Actara: Do not apply when bees are in the orchard.</p>
Scab	Use one of the fungicides listed under Green tip . Reduce rate of Equal to 2.25 kg/ha in cover sprays.		
Special spray (when monitoring indicates the need at First cover)			
Blister mite	<ul style="list-style-type: none">• Thiodan 50 WP or Thionex 50 W• Sevin XLR	<div>4.50 kg</div> <div>4.50 kg</div> <div>6.25 L</div>	
Summer sprays			
Pear psylla	<ul style="list-style-type: none">• Thiodan 50 WP or Thionex 50 W• Assail 70 WP• Surround WP• Decis 5 EC• Ripcord 400 EC• Pounce• Matador 120 EC• Pyramite or Nexter• Guthion 50 WSB or Sniper	<div>6.75 kg</div> <div>6.75 kg</div> <div>120 g</div> <div>50.00 kg</div> <div>350 mL</div> <div>175 mL</div> <div>520 mL</div> <div>83 mL</div> <div>600 g</div> <div>600 g</div> <div>see label</div> <div>see label</div>	<p>Apply when majority of the population is in early instar stages.</p> <p>Do not exceed maximum number of applications for any product. See Table 7-9, <i>Products Used on Pears</i>, on page 172.</p> <p>Surround: See <i>Particle film technology</i>, on page 10.</p>
Codling moth	<ul style="list-style-type: none">• Calypso 480 SC• Imidan 50 WP• Guthion 50 WSB or Sniper	<div>440 mL</div> <div>3.75 kg</div> <div>see label</div> <div>see label</div>	<p>Codling moth can be a problem if pear plantings are located near wild apple, wild pear and other hosts infested with codling moth. Agri-Mek in pear psylla programs provides no protection of fruit against codling moth. For sites with a history of codling moth damage, apply one of these insecticides. Use codling moth timing as recommended for apple.</p>
Obliquebanded leafroller	<ul style="list-style-type: none">• Dipel 2X DF or Foray 48BA or Bioprotec CAF• Success 480 SC or Entrust 80 W• Intrepid 240 F• Imidan 50 WP• Guthion 50 WSB or Sniper	<div>1.12 kg</div> <div>2.80 L</div> <div>4.00 L</div> <div>182 mL</div> <div>109 g</div> <div>750 mL</div> <div>3.75 kg</div> <div>see label</div> <div>see label</div>	<p>All of these products will only suppress leafroller populations.</p> <p>Resistance to the organophosphates such as Imidan and Guthion may be present.</p> <p>Routine monitoring is essential to determine timing for applications and for efficacy of sprays.</p>
Mites	<ul style="list-style-type: none">• Envidor 240 SC• Pyramite or Nexter• Carzol SP• Kelthane 50 W• Kanemite 15 SC	<div>750 mL</div> <div>300 g</div> <div>300 g</div> <div>1.10 kg</div> <div>3.25 kg</div> <div>2.10 L</div>	<p>Examine orchards for red mite and rust mite injury about July 15–20 or 10–15 days after using a pyrethroid. Check Preharvest intervals on page 172. Alternate miticides.</p> <p>Carzol: Is harsh on beneficial mites.</p> <p>Kanemite: Is not effective on rust mites.</p>

Diseases and Insects	Materials	Amount/ha	Comments
Second cover			
Oriental fruit moth	• Decis 5 EC	250 mL	Begin applications at egg hatch, usually 3–6 days after peak OFM flight as indicated by regional trap catches. Alternate products from different families to prevent the development of resistance. See Table 7-9. <i>Products Used on Pears</i> , on pages 172–173. Decis: Maximum three sprays per season. Assail: Maximum of four applications per season.
	• Assail 70 WP	240 g	
	• Calypso 480 SC	440 mL	
Scab	Use one of the fungicides listed under Green tip . Reduce rate of Equal to 2.25 kg/ha in cover sprays. Check Preharvest intervals on pages 172–173.		
Sooty blotch	• Supra Captan 80 WDC or Maestro 80 DF • Flint 50 WG	3.75 kg 3.75 kg 140 g	Repeat spray for sooty blotch 2 weeks later. Do not use Captan or Maestro on d'Anjou pears.
Special sprays (when monitoring indicates the need about mid-Aug. and early Sept.)			
Codling moth	• Calypso 480 SC • Assail 70 WP • Imidan 50 WP • Guthion 50 WSB or Sniper	440 mL 170 g 3.75 kg see label see label	Codling moth can infest pear as maturation and ripening begins. Bosc pears can be heavily infested and may require two preharvest sprays about 2 weeks apart.
Oriental fruit moth	• Decis 5 EC • Assail 70 WP • Calypso 480 SC	250 mL 240 g 440 mL	For Bosc, d'Anjou and Bartlett a spray 7–10 days prior to harvest is recommended in orchards adjacent to or near peaches.
Postharvest fruit treatment			
Blue mould	• Mertect SC • Scholar 50 WP	500 mL/ 500 L water 227 g/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. Mertect: For use in dip tank or drencher. Continuous agitation required. Follow label instructions. Does not control any blue mould (<i>Penicillium</i>) or grey mould (<i>Botrytis</i>), which is resistant to benzimidazole fungicides (e.g., Benlate). Scholar: Scholar also controls grey mould. See label for dip and drench instructions.

TABLE 7-9. Products Used on Pears

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Actara 25 WG	thiamethoxam	neonicotinoid	60	12 hours	2
Agri-Mek 1.9% EC	abamectin	avermectin	28		1 or 2 (max. 1.5 L/ha)
Assail 70 WP	acetamiprid	neonicotinoid	7	12 hours	4
Bioprotec CAF	<i>Bacillus thuringiensis</i>	B.t. microbial	1		
Calypso 480 SC	thiacloprid	neonicotinoid	30	12 hours	3 (max. 875 mL/ha)
Carzol SP	formetanate hydroxychloride	carbamate	1		4.48 kg/ha after calyx

*Except 4 days for thinning.

** Depends on rate, see label.

*** May be more or less for some tasks, see label.

TABLE 7-9. Products Used on Pears (cont'd)

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Decis 5 EC	deltamethrin	pyrethroid	7		3
Dikar	mancozeb + dinocap	dithiocarbamate	45	48 hours	
Dipel 2X DF	<i>Bacillus thuringiensis</i>	B.t. microbial	1		
Entrust 80 W	spinosad	naturalyte	7		3
Envidor 240 SC	spirodiclofen	tetronic acid derivative	7	12 hours	1
Equal 65 WP	dodine	guanidine	7		
Flint 50 WG	trifloxystrobin	strobilurin	14	12 hours*	4
Foray 48 BA	<i>Bacillus thuringiensis</i>	B.t. microbial	1		
Guthion 50 WSB	azinphosmethyl	organophosphate	14-21**	14 days	3
Imidan 50 WP	phosmet	organophosphate	1		
Intrepid 240 F	methoxyfenozide	ecdysone agonist	14		2 L/ha
Kanemite 15 SC	acequinocyl		14	12 hours	4.1 L/ha
Kelthane 50 W	dicofol	diphenylethane	7		1
Maestro 80 DF	captan	phthalimide	7	48 hours	
Matador 120 EC	cyhalothrin-lambda	pyrethroid	7	24 hours	1
Mertect SC	thiabendazole	benzimidazole	postharvest		
Nexter	pyridaben	pyridazinone	25	24 hours	2
Pounce	permethrin	pyrethroid	7		
Pyramite	pyridaben	pyridazinone	25	24 hours	2
Ripcord 400 EC	cypermethrin	pyrethroid	7		2
Scala SC	pyrimethanil	anilinopyrimidine	72	24 hours	4
Scholar 50 WP	fludioxonil	phenylpyrrole	postharvest		
Sevin XLR	carbaryl	carbamate	11		
Sniper	azinphosmethyl	organophosphate	14-21**	14 days	3
Sovran	kresoxim-methyl	strobilurin	30	48 hours	4
Streptomycin 17	streptomycin	antibiotic	30	7 days***	3
Success 480 SC	spinosad	spinosyn	7		3
Superior 70 Oil	mineral oil		use prebloom		
Supra Captan 80 WDG	captan	phthalimide	7	48 hours	
Surround WP	kaolin		0		
Thiodan 50 WP	endosulfan	chlorinated cyclodiene	15		2
Thionex 50 W	endosulfan	chlorinated cyclodiene	15		3

*Except 4 days for thinning.

** Depends on rate, see label.

*** May be more or less for some tasks, see label.

Thinning Pears

The major pear cultivars grown in Ontario benefit from fruit thinning. The thinning of fruit is particularly beneficial during seasons of heavy fruit set or inadequate moisture. Bartlett and Bosc can set fruit in clusters of three to five fruit per spur. See notes on irrigation under *Thinning peaches*, on page 166.

- If fruit set is excessive, reduce the number of fruit per cluster to one or two. If the set on the tree is not excessive, multiple fruit per cluster will reach a satisfactory size without fruit thinning. To obtain large sized fruit, irrigate after shuck split, in extended dry periods in midsummer and a few weeks before harvest.
- Start thinning near the end of June drop (mid-June) when it can be determined which fruit will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning.
- Thin pears on dwarfing rootstock in order to obtain a high percentage of marketable fruit and prevent limb breakage.

- Defruit trees during the first four years of establishment. Reduce the crop to one fruit per spur, spaced 12–15 cm apart during normal years. The combination of proper fruit thinning and irrigation has the most positive results on pear fruit size.
- Response of pears to chemical thinners, under Ontario conditions, is inconsistent between years. Try chemical thinning on a small scale until response with respect to tree vigour, cultivar and fruit size can be evaluated. Use either NAA (*naphthaleneacetic acid*) or NAD (*naphthaleneacetamide*) for chemical thinning. Suggested rates are: NAA at a concentration of 15–20 ppm approximately 3–6 days after petal fall, or NAD at 10 ppm, 6–9 days after petal fall, depending on tree vigour and amount of thinning desired. For specific application instructions consult the product label.

Plum Calendar

Read the label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, on page 13.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-10. *Products Used on Plums*, on page 177.

Diseases and Insects	Materials	Amount/ha	Comments
Green tip (just as buds are bursting)			
European red mite Scale insects	• Superior 70 Oil	20 L/1,000 L water	Spray on a calm day to improve coverage.
Prebloom (when blossoms show white)			
Brown rot	<ul style="list-style-type: none"> • Topas 250 E or Mission 418 EC • Rovral • Supra Captan 80 WDG or Maestro 80 DF • Microscopic Sulphur • Funginex DC • Vanguard 75 WG • Lance WDG • Indar 75 WSP • Pristine WG 	500 mL 300 mL 1.50 kg 4.50 kg 4.50 kg see label 2.50 L 370 g 370 g 140 g 750 g	<p>To help control brown rot, knock off fruit mummies when pruning. Cultivate entire orchard before bloom. Make two to three fungicide applications from early to full bloom. To avoid resistance, alternate between fungicides and do not use more than two applications of Rovral or Vanguard per year.</p> <p>Sulphur: Helps control rust mites on European plums and prunes.</p> <p>Captan or Maestro: May cause injury under some circumstances. Injury has occurred on Grand Prize, Early Golden, Shiro, Burbank and Ozark Premier.</p> <p>Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.</p> <p>Topas/Mission and Indar: From the same chemical family. Do not alternate Topas/Mission and Indar.</p>
Black knot	<ul style="list-style-type: none"> • Supra Captan 80 WDG or Maestro 80 DF • Indar 75 WSP • Topas 250 E or Mission 400 EC 	4.50 kg 4.50 kg 140 g 500 mL 300 mL	<p>Fungicides will not provide adequate control of black knot without proper orchard sanitation (pruning, removal, and burning of black knots). Destroy affected wild and neglected plums near orchard. Cut out all black knots before March. Make the cut 15 cm below the swelling. Collect and burn all prunings with knots. Knots left lying on the ground are a source of spores that start new infections. Inspect all plums in early summer for new knots and those missed. Cut these out and burn them. European plums, prunes and Damsons are most susceptible. Apply fungicide sprays to protect the developing shoots between the popcorn stage (prebloom) and first cover every 3–5 days in wet weather. Spore release may be delayed in dry springs. Under these conditions extend fungicide coverage to First Cover. See OMAFRA Factsheet, <i>Black Knot of Plums</i>, Order No. 05-017.</p> <p>Topas/Mission: Provides only suppression of black knot, see label.</p>
Consider both European and Japanese plums as self-unfruitful. Mixed plantings and insect pollinators are essential. Honeybees readily work plum blossoms.			
Bloom			
DO NOT APPLY INSECTICIDES WHILE PLUM TREES ARE IN BLOOM. SEE BEE POISONING ON PAGE 192.			
Brown rot (Blossom blight)	Use one of the fungicides listed under Prebloom .		

Diseases and Insects	Materials	Amount/ha	Comments
Shuck (when most of the shucks are off)			
Brown rot	<ul style="list-style-type: none">• Topas 250 E or Mission 418 EC• Rovral• Microscopic Sulphur• Supra Captan 80 WDG or Maestro 80 DF• Vanguard 75 WG• Lance WDG• Indar 75 WSP• Pristine WG	500 mL 300 mL 1.50 kg see label 4.50 kg 4.50 kg 740 g 370 g 140 g 750 g	To avoid resistance, alternate between fungicides and do not use more than two applications of Vangard or Rovral per season. Captan or Maestro: May cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances. Pristine and Lance: Include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.
Black knot	<ul style="list-style-type: none">• Supra Captan 80 WDG or Maestro 80 DF• Indar 75 WSP	4.50 kg 4.50 kg 140 g	Captan or Maestro: May cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances. Fungicides will not provide adequate control of black knot without proper orchard sanitation (pruning, removal, and burning of black knots).
Plum curculio	<ul style="list-style-type: none">• Guthion 50 WSB or Sniper• Imidan 50 WP	see label see label 3.75 kg	If temperatures are high, spray when the shucks split.
European red mite	<ul style="list-style-type: none">• Kelthane 50 W	3.25 kg	If oil was used at green tip, a spray for mites is likely not required at this time unless leaf bronzing is apparent on new shoot tissue.
First cover (12 days after Shuck)			
Brown rot Leaf spot Black knot	Use one of the fungicides listed under Shuck .		Captan or Maestro: May cause leaf injury and spotting on the fruit of Stanley and Japanese plums under some circumstances.
Plum curculio	Use one of the insecticides listed under Shuck .		
Summer spray			
European red mite	<ul style="list-style-type: none">• Kelthane 50 W	3.25 kg	Repeated use of Kelthane has led to resistant mite populations in the past. Monitor carefully and use a miticide only if leaf bronzing is apparent on new leaf tissue.
Second cover			
Brown rot	<ul style="list-style-type: none">• Topas 250 E or Mission 418 EC• Rovral• Microscopic Sulphur• Supra Captan 80 WDG or Maestro 80 DF• Vanguard 75 WG• Lance WDG• Indar 75 WSP• Pristine WG	500 mL 300 mL 1.50 kg see label 4.50 kg 4.50 kg 740 g 370 g 140 g 750 g	During wet weather repeat applications between pickings. Check Preharvest interval. See Table 7-10, <i>Products Used on Plums</i> , on page 177. Topas/Mission: No more than two applications in the 3 weeks prior to harvest. Pristine and Lance: Both products include active ingredients in the same fungicide family. Do not alternate Pristine with Lance.
Prepick			
Brown rot	Use one of the fungicides listed under Second cover .		
Special sprays (when monitoring indicates the need)			
Aphids	<ul style="list-style-type: none">• Thiodan 50 WP or Thionex 50 W• Diazinon 50 W	3.25 kg 3.25 kg 3.00 kg	Apply only if aphids are a problem. Very thorough coverage and calm warm conditions are needed for good control.
Apple maggot	<ul style="list-style-type: none">• Diazinon 50 W• Imidan 50 WP	3.00 kg 3.75 kg	If apple maggot has been a problem on blue plums and prunes, apply two or three sprays during July and August.

Diseases and Insects	Materials	Amount/ha	Comments
Peachtree borer Lesser peachtree borer	<ul style="list-style-type: none"> Thiodan 50 WP or Thionex 50 W or Thiodan 4EC Sevin XLR 	1.5 kg/1,000 L 1.5 kg/1,000 L 1.75 L/1,000 L 6.25 L	Apply three sprays, 3 weeks apart. Apply first spray 10 days after first adult catch in pheromone traps. Direct these sprays with a handgun to cover trunk and scaffold limbs thoroughly. Check preharvest intervals and do not spray if fruit is to be harvested during this period.
Obliquebanded leafroller	<ul style="list-style-type: none"> Success 480 SC or Entrust 80 W 	182 mL 109 g	
Postharvest fruit treatment			
Blue mould, grey mould, brown rot, rhizopus rot	<ul style="list-style-type: none"> Scholar 50 WP 	227 g/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions. Scholar: Should not be used on plums intended for processing into prunes.

TABLE 7-10. Products Used on Plums

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume the spray solution must be dry before re-entry can occur.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Diazinon 50 W	diazinon	organophosphate	10		
Entrust 80 W	spinosad	naturalyte	7		3
Funginex DC	triforine	piperazine	do not apply after bloom		3
Guthion 50 WSB	azinphosmethyl	organophosphate	15	14 days	2
Imidan 50 WP	phosmet	organophosphate	1		
Indar 75 WSP	fenbuconazole	triazole (DMI)	1	12 hours	7
Kelthane 50 W	dicofol	diphenylethane	7		1
Lance WDG	boscalid	anilide carboxamide	0	4 hours	5
Maestro 80 DF	captan	phthalimide	2	48 hours	
Microscopic Sulphur	sulphur	inorganic	1		
Mission 418 EC	propiconazole	triazole (DMI)	3	72 hours	5*
Pristine WG	boscalid + pyraclostrobin	anilide carboxamide + QoI	0	24 hours for hand harvest, 10 days for hand thinning	5
Rovral	iprodione	dicarboximide	1	12 hours	
Scholar 50 WP	fludioxonil	phenylpyrrole	postharvest		
Sevin XLR	carbaryl	carbamate	2		
Sniper	azinphosmethyl	organophosphate	15	14 days	2
Success 480 SC	spinosad	naturalyte/spinosyn	7		3
Superior 70 Oil	mineral oil		use prebloom		

* No more than two applications in the 3 weeks prior to harvest.

TABLE 7-10. Products Used on Plums (cont'd)

Product name	Common name	Group	Preharvest interval (days)	Minimum re-entry	Maximum # of applications per season
Supra Captan 80 WDG	captan	phthalimide	2	48 hours	
Thiodan 4 EC	endosulfan	chlorinated cyclodiene	15		3
Thiodan 50 WP	endosulfan	chlorinated cyclodiene	15		3
Thionex 50 W	endosulfan	chlorinated cyclodiene	15		3
Topas 250 E	propiconazole	triazole (DMI)	3	72 hours	5*
Vangard 75 WG	cyprodinil	anilinopyrimidine	2	72 hours	4

* No more than two applications in the 3 weeks prior to harvest.

Notes on Plums

Heat spot

High temperatures may cause purplish spots on plum and prune fruits that exude clear gum. These spots develop about 5–8 days after a hot spell. Summer cover crops and mulch help to reduce this physiological disease.

To reduce this disorder on prunes, spray with 4 kg of calcium chloride in 1,000 L of water during the period from early July to mid-August. Apply three sprays, 10–12 days apart.

Thinning Plums

In recent years, the market demand for larger fruit has placed more importance on fruit thinning, pruning and irrigation. Japanese plums require systematic

fruit thinning; otherwise fruit size will be small and biennial cropping will ensue. European plums grown for fresh market also require thinning in the years of heavy fruit set. Inadequate fruit thinning results in production of under-sized plums and, at times, fruit ripening on overloaded trees will be delayed. Irrigation is important to obtain large-sized fruit. See notes on irrigation under *Thinning peaches*, on page 166. Start thinning near the end of June drop in early to mid-June when it can be determined which fruit will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning.

Fruit size thinning is preferred to conventional space thinning. Size thinning selectively removes small, weak, blemished or diseased fruit regardless of spacing of the fruits on the branches. The end result should be proper sizing of the fruit remaining on the tree.

Notes on Fungicides for Tender Fruit

TABLE 7-11. Activity of Fungicides on Stone Fruit Diseases

Ratings in shaded cells indicate the disease is listed on the product label for control or suppression. Please see the product label or crop calendars for registered uses. Use fungicides only for diseases listed on the product label for the crop and for the disease. Additional information is provided in this table to assist the grower in choosing the best fungicide for control of diseases listed on the product label.

Group	Brand Name	Brown rot blossom blight	Brown rot fruit phase	Rhizopus rot	Cherry leaf spot	Powdery mildew	Black knot	Peach leaf curl	Registered for use on:			
									Apricots	Cherries	Peaches	Plums
M1	Kumulus DF	++	+	0	+	++	+ to ++	NA		✓	✓	✓
M1	Microscopic Sulfur	++	+	0	+	++	+ to ++	NA		✓	✓	✓
M2	Ferbam 76 WDG	0	0	NA	++	0	0	++++	✓	✓	✓	✓
M3	Captan 80 WDG	+++	+++	+	+++	0	++	+++	✓	✓	✓	✓
M3	Maestro 80 DF	+++	+++	+	+++	0	++	+++	✓	✓	✓	✓
M4	Bravo 500	+++	NA	NA	++++	0	++++	++++		✓	✓	
2	Rovral	++++	++++	++	++	0	0	NA	✓	✓	✓	✓
3	Funginex DC	+++	NA	NA	+++	+++	0	0		✓	✓	✓
3	Indar 75 WSP	++++	++++	0	+++	+++	++	NA	✓	✓	✓	✓
3	Nova 40 W	+	NA	0	+++	++++	0	NA		✓	✓	
3	Topas 250 E	++++	++++	++++	+++	+++	++	NA	✓	✓	✓	✓
3	Mission 418 EC	++++	++++	++++	+++	+++	++	NA	✓	✓	✓	✓
7	Lance WDG	++++	++++	0	?	++	?	NA	✓	✓	✓	✓
7&11	Pristine WG	++	++	++++	++++	++	?	NA	✓	✓	✓	✓
9	Vanguard 75 WG	+++	+++	+++	?	0	0	NA	✓		✓	✓
11	Cabrio EG	++	++	++++	++++	++++	?	NA	✓	✓	✓	✓
12	Scholar	NA	++++	++++	NA	NA	NA	NA	✓	✓	✓	✓
14	Botran 75 W	0	0	++	0	0	0	0			✓	
17	Elevate 50 WDG	+++	+++	0	0	0	0	0		✓	✓	

✓ Registered on the crop. NA = Not used at this timing for this pest.

Legend: 0 = Not effective; + = Slight effect; ++ = Fair; +++ = Good; ++++ = Very good; ? = Unknown.

Source: McSmith Agricultural Research Services.

8. Tree Nuts

Walnut Calendar

Read the label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

Diseases and Insects	Materials	Amount	Comments
Prebloom			
Leafrollers	• Dipel 2X DF	1.12 kg/ha	Apply when small larvae are present. Apply in 600–800 L/ha using an orchard air-blast sprayer. Repeat in 7–10 days or after bloom if populations are large. Although Dipel is not toxic to bees, avoid application during bloom. Use 1.6 kg/ha for large or mature trees.
1st pistillate flower			
Butternut curculio	• Surround WP	50.00 kg/ha	Apply when visual inspection shows adult feeding and egg laying scars on new flower shoots. See <i>Particle film technology</i> , on page 10.
Walnut blight	• Copper Spray	4.00 kg/1,000 L	Apply in sufficient water to ensure complete coverage.
Summer sprays			
Codling moth	• Surround WP	50.00 kg/ha	Apply when pheromone traps indicate adult activity. See <i>Particle film technology</i> , on page 10.
Husk maggot	• Surround WP	50.00 kg/ha	Apply when sticky traps show adult activity, typically August to mid September. See <i>Particle film technology</i> , on page 10.
Walnut blight	• Copper Spray	4.00 kg/1,000 L	Apply in sufficient water to ensure complete coverage. Apply monthly until husks split, but not after husks split. Do not apply more than four times per season. Do not apply within 40 days of harvest.
Aphids	• Malathion 500 EC	2.50 L/1,000 L	For use on young non-bearing trees only. When aphid colonies are still young, apply in enough water to thoroughly wet the leaves throughout the canopy.

Pecan and Sweet Chestnut Calendar

Read the label and follow all safety precautions.

Diseases and Insects	Materials	Amount	Comments
Prebloom			
Leafrollers	• Dipel 2X DF	1.12 kg/ha	Apply when small larvae are present. Apply in 600–800 L/ha using an orchard air-blast sprayer. Repeat in 7–10 days or after bloom if populations are large. Although Dipel is not toxic to bees, avoid application during bloom. Use 1.6 kg/ha for large or mature trees.
Aphids	• Malathion 500 EC	2.50 L/1,000 L	For use on young non-bearing trees only. Apply when aphid colonies are young, with enough water to thoroughly wet the leaves throughout the canopy.

Filbert/Hazelnut Calendar

Read the label and follow all safety precautions.

Diseases and Insects	Materials	Amount	Comments
Dormant			
Eastern filbert blight	• Guardsman Copper Oxychloride 50 or Copper Spray	3.00 kg/ha	Apply during the spring at bud swell and repeat at 10–14 day intervals for a maximum of three applications per year. Use 3.0 kg/ha on small trees and up to 9.0 kg/ha on large trees. May be applied up to one day before harvest.
		3.00 kg/ha	
Prebloom			
Leafrollers	• Dipel 2X DF	1.12 kg/ha	Apply when small larvae are present. Apply in 600–800 L/ha using an orchard air-blast sprayer. Repeat in 7–10 days or after bloom if populations are large. Although Dipel is not toxic to bees, avoid application during bloom. Use 1.6 kg/ha for large or mature trees.
Summer			
Aphids	• Lagon 480 E	5.00 L/ha	Apply primarily on younger trees when aphids appear. Use reduced rate for smaller, immature trees. Do not apply within 45 days of harvest. One application per year. Malathion: Use on non-bearing trees only. Apply when aphid colonies are still young, with enough water to thoroughly wet the leaves, throughout the canopy.
	• Malathion 500 EC	2.50 L/1,000L	
Postharvest			
Bacterial blight	• Guardsman Copper Oxychloride 50 or Copper Spray	3.00 kg/ha	Apply the first spray in late August or early September before the start of the fall rains and nut drop. Repeat after harvest at ½ leaf fall. Repeat in early spring just before leaf bud break. Use 3.0 kg/ha on small trees, and up to 9.0 kg/ha on large trees in proportionately more water.
		3.00 kg/ha	

TABLE 8-1. Products Used on Nut Crops

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Common name	Group	Preharvest interval (days)	Maximum # of applications per season
Copper Spray ^{1, 2}	copper from copper oxychloride	inorganic	40	3
Dipel 2X DF ^{1, 2, 3}	<i>Bacillus thuringiensis</i>	B.t. microbial	1	
Guardman Copper Oxychloride 50 ²	copper from copper oxychloride	inorganic	1	3
Lagon 480 E ²	dimethoate	organophosphate	45	1
Malathion 50:0 EC ^{1, 2, 3}	malathion	organophosphate	for use on non-bearing only	
Surround WP ¹	kaolin		0	

¹ Walnut
² Filbert/hazelnut
³ Pecan and sweet chestnut

9. Information on Pesticides

Relative Acute Toxicity of Pesticides

Acute toxicity is the toxic response that results from a single exposure to the pesticide. The symbols and words on the front panel of a pesticide label give you information about the acute toxicity. Table 9-1. *Relative Acute Toxicity of Pesticides and Plant Growth*

Regulators lists products in this publication according to the relative acute toxicity and warning symbol on the label. This table does not provide information on chronic toxicity. Chronic toxicity is the toxic response that results from repeated exposures to small doses of a pesticide over a longer time period.

TABLE 9-1. Relative Acute Toxicity of Pesticides and Plant Growth Regulators

Use this table as a guide, but refer to the product label for specific information.

Danger Symbol/ Toxicity Level	Products		
Danger Poison Symbol High Acute Toxicity	Calypso 480 SC*	Guthion 50 WSB	Telone C-17
	Carzol SP	Imidan 50 WP	Telone II
	Chloropicrin 100*	Lannate	Thiodan 4 EC
	Decis 5 EC*	Lorsban 50 W	Thiodan 50 WP
	Diazinon 500 E	Malathion 500 EC	Thionex 50 WP
	Diazinon 50 W	Matador 120 EC	Vydate L
	Furadan 480 F	Sniper	Zolone Flo
Warning Poison Symbol Moderate Acute Toxicity	Agri-Mek 1.9% EC	Ground Force	Pyramite*
	Assail 70 WP	Guardsman Copper Oxychloride 50	Ramik Brown
	Busan 1020*	Guardsman Dormant Oil Spray	Ridomil Gold 480 SL
	Copper 53 W	Lagon 480 E	Sevin XLR
	Copper Spray	Manzate Pro-Stick	Tanos 50 DF*
	Cygon 480-Ag	Mission 418 EC	Vapam*
	Folpan 80 WDG	Nexter	Zinc phosphide
Caution Poison Symbol Lower Acute Toxicity	Accel	Folpan 80 WDG*	Pounce
	Admire 240 F	Kelthane 50 W*	Ripcord 400 EC
	Alias 240 SC	Lance WDG*	Ronilan EG
	Aliette WDG*	Maestro 80 DF*	Rovral
	Apollo SC	Malathion 25 W	Scala SC*
	Botran 75 W	Malathion 500 E	Sovran*
	Captan 80 WDG*	Microscopic Wettabl. Sulphur	Superior 70 Oil
	Elevate 50 WDG	Nova 40 W	Topas 250 EC*
	Envidor SC	Orthene 75% SP	Vangard 75 WG

* Other warnings about specific hazards such as corrosiveness and skin or eye irritations are not included in this table but can be found on the product label.

TABLE 9-1. Relative Acute Toxicity of Pesticides and Plant Growth Regulators (cont'd)

Danger Symbol/ Toxicity Level		Products	
No Poison Symbol Very Low Acute Toxicity	Actara 25 WG*	Flint 50 WG*	Nustar
	Acramite 50 WS*	Foray 48BA	Penncozeb 75 DF*
	Amid-Thin	Fruitone N	Polyram DF
	Apogee	Funginex DC	Pristine WG
	Bioprotec CAF	Gavel 75 DF*	Promalin*
	Bravo 500*	GF-120 NF	ReTain
	Cabrio EG	Indar 75 WSP	Ridomil Gold Mz 68 WP
	Confirm 240 F	Isomate GBM plus	Rimon 10 EC
	Dikar	Isomate M 100	Scholar 50 WP
	Dipel 2X DF	Isomate M Rosso	Senator 70 WP
	Dithane DG	Intrepid 240 F	Serenade Max
	Entrust 80 W	Kanemite 15 SC	Sluggo
	Equal 65 WP	Kumulus DF	Switch 62.5 WG
	Ethrel*	Lime Sulphur*	Streptomycin 17
	Falgro Tablets	MilStop	Success 480 SC
	Ferbam 76 WDG	Mertect SC	Surround WP

* Other warnings about specific hazards such as corrosiveness and skin or eye irritations are not included in this table but can be found on the product label.

Re-entry Interval

The re-entry interval, also referred to as Restricted Entry Interval (REI), is the period of time following a pesticide application during which workers must not enter the treatment area without wearing protective clothing and personal protective equipment. This allows any pesticide residue and vapours to dissipate from the field, preventing the possibility of inadvertent pesticide poisoning.

Health Canada reviews each pesticide to determine whether the label should include a specific re-entry

interval. If no re-entry interval is stated on the label, assume that the spray solution must be dry before re-entry can occur. Re-entry intervals can vary for different crops and different tasks.

Table 9-2. *Re-entry Intervals for Pesticides and Plant Growth Regulators*, on page 187–188, shows specific minimum intervals between the application of pesticide and working in the treated crop without protective equipment. Use this table as a guide, but refer to the product label for specific information.

TABLE 9-2. Re-entry Intervals for Pesticides and Plant Growth Regulators

Minimum interval before re-entry	Product trade name	Special comments See label for details
4 hours	Elevate 50 WDG	
	Falgro Tablets	
	Lance WDG	
	MilStop	
12 hours	Actara 25 WG	
	Acramite 50 WS	Except 2-5 days for hand labour on grapes, depending on the task (see label).
	Apogee	
	Apollo SC	
	Assail 70 WP	
	Calypso 480 EC	
	Envidor 240 SC	Except 6 days for some tasks requiring hand labour on grapes (see label).
	Flint 50 WG	Except 4 days for hand thinning on apples and pears, and 5 days for hand labour on grapes.
	Indar 75 WSP	
	Kanemite 15 SC	
	Nustar	
	Ridomil Gold MZ 68 WP	
	Ridomil Gold 480 SL	
	Rimon 10 EC	
	Rovral	
	Switch 62.5 WG	
24 hours	Admire 240 F	
	Alias 240 SC	
	Cabrio EG	1 day for hand labour on strawberries, 10 days for hand labour on stone fruit (apricots, peaches, cherries, plums), 29 days for hand labour on blueberries. Otherwise, wait until the product is dried.
	Folpan 80 WDG	
	Kumulus DF	
	Lannate	
	Malathion 500 E	
	Matador 120 EC	
	Microscopic Sulphur	
	Nexter	
	Penncozeb 75 DF	
	Pristine WG	24 hours for hand labour on strawberries, raspberries, and for hand harvest of stone fruit. Otherwise, wait until product is dried. Longer intervals for hand thinning and other crops, see <i>Greater than 7 days</i> , on page 188.
	Pyramite	
	Scala SC	For hand labour (i.e. thinning, pruning, etc).
	Tanos 50 DF	
	Zolone Flo	

TABLE 9-2. Re-entry Intervals for Pesticides and Plant Growth Regulators Used on Fruit Crops (cont'd)

Minimum interval before re-entry	Product trade name	Special comments See label for details
48 hours	Bravo 500	
	Captan 80 WDG	48 hours for tree fruit and strawberries. 72 hours for grapes, raspberries and blueberries.
	Dikar	See label for special precautions.
	Funginex DC	
	Furadan 480 F	
	Gavel 75 DF	
	Maestro 80 DF	48 hours for tree fruit and strawberries. 72 hours for grapes, raspberries and blueberries.
	Sovran	
	Vanguard 75 WG	48 hours for grapes, 72 hours for apples and stone fruit.
	Vydate	
72 hours	Captan 80 WDG	48 hours for tree fruit and strawberries. 72 hours for grapes, raspberries and blueberries.
	Maestro 80 DF	48 hours for tree fruit and strawberries. 72 hours for grapes, raspberries and blueberries.
	Mission 418 EC	
	Orthene 75% SP	
	ReTain	
	Ronilan EG	
	Telone II	
	Telone C-17	
	Topas 250 EC	
	Vanguard 75 WG	48 hours for grapes, 72 hours for apples and stone fruit.
4 days	Lorsban 50 W	For peaches; less for other crops on label.
5 days	Flint 50 WG	For hand labour on grapes.
7 days	Success	For hand labour on grapes.
	Streptomycin 17	Less for certain tasks with protective clothing and equipment.
Greater than 7 days	Cabrio EG	1 day for hand labour on strawberries, 10 days for hand labour on stone fruit (apricots, peaches, cherries, plums), 29 days for hand labour on blueberries. Otherwise, wait until the product is dried.
	Chloropicrin 100	
	Flint 50 WG	12 days for girdling grapes.
	Guthion 50 WSB	7 days for raspberries, 14 days for tree fruits, except 15 days for cherries. 28 days for grapes, 30 days for non-ag workers (i.e. pick-your own customers).
	Pristine WG	29 days for hand labour on blueberries, currant and gooseberries. 10 days for hand thinning fruit trees. 24 hours for hand harvest of fruit trees. Otherwise wait until product is dried.
	Sniper	See Guthion 50 WSB.

Days to Harvest Intervals

Health Canada has established amounts of pesticides that may remain on fruits at time of harvest. To avoid exceeding these tolerances, use recommended amounts. Do not spray nearer to harvest than number of days shown below and no later than stage indicated. For tank mixes of two or more materials,

use the longest period given for any of the materials. Be aware that many wineries and processors may require longer preharvest intervals than stated on product labels. Contact wineries or processors directly regarding their preharvest interval policy. Do not apply a pesticide more often than recommended on label.

TABLE 9-3. Number of Days from Last Spray to Harvest

	Apple	Apricot	Blueberry	Currant and Gooseberry	Cherry	Grape	Peach	Pear	Plum	Raspberry	Saskatoon berries	Strawberry	Tree nuts
Acramite 50 WS	7					14							
Actara 25 WG	60							60					
Admire 240 F	7		14				7						
Agri-Mek 1.9 EC	28							28		AH		3	
Alias 240 SC	7		14										
Aliette WDG	30									60		30	
Apogee	45												
Apollo SC	A						A, 21			15		15	
Assail 70 WP	7					7		7					
Bioprotec CAF	1	1			1			1		1			
Botran 75 W							10						
Bravo 500			54		40		60					30	
Cabrio EG			29		10							1	
Calypso 480 SC	30							30					
Carzol SP	1						21	1					
Confirm 240 F	14												
Copper 53 W	30			1								1	
Copper Spray													40
Cygon 480-Ag			15									7	
Decis 5 EC	1		14				1	7				14	
Diazinon 50 W	14			PB	10	16			10	PB			
Diazinon 500 E	14			PB						PB			
Dikar	45					30		45					
Dipel 2X DF	1	1	1		1			1		1			1
Dithane DG	45												
Elevate 50 WDG			1	1	1	7	1			1		1	
Entrust 80 W	7	14			7			7	7				
Envirdor 240 SC	7	7			7	14	7	7					
Equal 65 WP					7			7				7	
Ferbam 76 WDG	7		40	14	4	7	21			PB			

A – Within 14 Days of Petal Fall; PB – Prebloom; AH – After Harvest; V – Vegetative or Non-Bearing Year Only;

DD – Delayed Dormant; PHF – Post Harvest Fruit Treatment.

⁹⁰ Check with processor and winery for days to harvest on wine grapes.

¹ 14 days for Botrytis, 72 days for apple scab.

^{*} 2 days on sweet cherry ^{**} 1 day on table grapes † Do not use on sweet cherries ‡ Depends on rate, see label

TABLE 9-3. Number of Days from Last Spray to Harvest (cont'd)

	Apple	Apricot	Blueberry	Currant and Gooseberry	Cherry	Grape	Peach	Pear	Plum	Raspberry	Saskatoon berries	Strawberry	Tree nuts
Flint 50 WG	14					14		14					
Folpan 80 WDG						1						1	
Foray 48 BA	1							1		1			
Funginex DC			60		PB		PB		PB		60		
Furadan 480 F												PB	
Gavel 75 DF						66							
GF-120 NF			0		0								
Guardman Copper Oxychloride													1
Guardman Dormant Oil			DD										
Guthion 50 WSB	14/ 21‡	21			15	28	21	14/ 21‡	15	AH			
Imidan 50 WP	1		15		7†	7		1	1				
Indar 75 WSP		1			1		1		1				
Intrepid 240 F	14							14					
Kanemite 15 SC	14							14					
Kelthane 50 W	7	14			7	7	14	7	7	7		7	
Kumulus DF	1				1	21**					1		
Lagon 480 E			15										45
Lance WDG		0	0	0	0	14	0		0	0		0	
Lime Sulphur			DD							DD			
Lorsban 50 W							21						
Maestro 80 DF	7	2	2		5*	7	2	7	2	2		2	
Malathion 25 W	3		1	3						1		3	
Malathion 500 E						3							
Malathion 500 EC													V
Manzate Pro-Stick	45												
Matador 120 EC	7						7	7				7	
Mertect SC	PHF							PHF					
Micrscopic Wettable Sulphur	1			1		21**	1		1				
Milstop						0							
Mission 418 EC		3	60		3		3		3		38		
Nexter	25				7†	25	14	25		AH		10	
Nova 40 W	14				1	14	1				14	3	
Nustar	77												
Orthene 75% SP											11 months		

A – Within 14 Days of Petal Fall; PB – Prebloom; AH – After Harvest; V – Vegetative or Non-Bearing Year Only;

DD – Delayed Dormant; PHF – Post Harvest Fruit Treatment.

† Check with processor and winery for days to harvest on wine grapes.

* 14 days for *Botrytis*. 72 days for apple scab.

** 2 days on sweet cherry ** 1 day on table grapes † Do not use on sweet cherries ‡ Depends on rate, see label

TABLE 9-3. Number of Days from Last Spray to Harvest (cont'd)

	Apple	Apricot	Blueberry	Current and Gooseberry	Cherry	Grape	Peach	Pear	Plum	Raspberry	Saskatoon berries	Strawberry	Tree nuts
Penncozeb 75 DF	45												
Polyram DF	45					45							
Pounce	7					21	7	7					
Pristine WG		0	0	0	0		0		0	0		1	
Pyramite	25				7†	25	14	25		AH		10	
Ridomil Gold 480 SL	V		80							V, AH		V, AH	
Ridomil Gold MZ 68 WP						66							
Rimon 10 EC	14												
Ripcord 400 EC	7					7	7	7				7	
Ronilan EG												3	
Rovral		1			1	7 ^{NB}	1		1	1		1	
Scala SC	14 ¹ , 72 ¹					7		72				1	
Scholar 50 WP	PHF	PHF			PHF		PHF	PHF	PHF				
Senator 70 WP										1			
Serenade Max			0	0		0				0		0	
Sevin XLR	11	5	2		2	5 ^{NB}	1	11	2	11			
Sluggo						0						0	
Sniper	14/ 21‡	21			15	28	21	14/ 21‡	15	AH			
Sovran	30					14		30					
Streptomycin 17	50							30					
Success 480 SC	7	14			7	7		7	7				
Supra Captan 80 WDG	7	2	2		5*	7	2	7	2	2		2	
Surround WP	0					0		0					0
Switch 62.5 WG			1							1		1	
Tanos 50 DF										0			
Thiodan 50 WP	15	15			15	30	15	15	15			7	
Thiodan 4 EC		15					15		15			7	
Thionex 50 WP	15	15			15	30	15	15	15			7	
Topas 250 E		3	60		3		3		3		38	1	
Vangard 75 WG	72	2				7	2		2				
Vydate	V									AH			
Zolone Flo	30				14								

A – Within 14 Days of Petal Fall; PB – Prebloom; AH – After Harvest; V – Vegetative or Non-Bearing Year Only;
DD – Delayed Dormant; PHF – Post Harvest Fruit Treatment.
^{NB} Check with processor and winery for days to harvest on wine grapes.
¹ 14 days for *Botrytis*, 72 days for apple scab.
* 2 days on sweet cherry ** 1 day on table grapes † Do not use on sweet cherries ‡ Depends on rate, see label

Bee Poisoning

Bees are essential for the pollination of most trees and small fruits. Insecticides, many of which kill bees, are required for insect control but with careful management, you can obtain both pollination and insect control. Growers can protect bees by following these suggestions:

- Before you apply a pesticide, advise local beekeepers so they can move colonies out of the danger area. Contact the Provincial Apiarist at 1-888-466-2372 ext. 63595 for a list of the beekeepers in your area or see ontario.ca/crops and click “Apiculture” for a list of provincial bee inspectors who know the local beekeepers.
- Do not apply insecticides while fruit trees are in bloom. The *Bees Act* makes it an offence to do so in Ontario. Do not spray any flowering crop on which bees are foraging and read the pesticide label for guidelines.
- Time insecticide applications to minimize bee poisoning. Daytime treatments, when bees forage in the field, are most hazardous. Insecticide applications in the evening are the safest. Spraying after 7 p.m. allows the spray to dry before the bees are exposed to it the next day. This is the most successful way to avoid bee damage. Early morning is the next best time, but spraying should be completed before 7 a.m. Bees do not usually forage at temperatures below 13°C. If you plan to spray in the morning, contact beekeepers with bees within 1 km of your crop. The beekeepers will then have the option of taking protective action.

- Wet bags in the entrance of the hive will disrupt the flight of the bees for up to 12 hours and provide more time for spray to dry. Leave an opening of 2.54 cm (1 inch) on each side of the hive entrance so the bees can get out and ventilate the hive.
- Remove honeybee colonies as soon as pollination is complete and before any postbloom insecticides are applied.
- Honeybees are frequently poisoned by visiting cover crops, such as dandelions or clovers that are in bloom in the orchard or field. Clip or beat down such crops prior to a spray to help safeguard the bees.
- Do not apply insecticide on windy days to prevent drift toward any nearby hives.
- If there is a risk of honeybee poisoning, try to choose an insecticide that is not highly toxic to the bees from the list in Table 9-4. *Relative Toxicity of Pesticides to Honeybees*, on page 193. When there is a choice, choose a product formulation that is less hazardous to bees. EC formulations are less toxic than WP formulations.

Table 9-4. *Relative Toxicity of Pesticides to Honeybees* shows the relative toxicity of products used on fruit crops to honeybees as determined by laboratory and field tests.

For more detailed information on the toxicity of specific pesticides to honeybees refer to the pesticide label.

TABLE 9-4. Relative Toxicity of Pesticides to Honeybees

Group I: Pesticides highly toxic to bees		Group II: Pesticides moderately toxic to bees		Group III: Pesticides relatively non-toxic to bees	
Severe losses may be expected if the following materials are used when bees are present at treatment time or within a few days thereafter.		These can be used around bees if dosage, timing, and method of application are correct, but do not apply directly on bees, in the field or at the colonies.			
Actara 25 WG	thiamethoxam	Acramite 50 WS	bifenazate	Aliette WDG	fosetyl al
Admire 240 F	imidacloprid	Assail 70 WP	acetamiprid	Apogee	prohexadione calcium
Agri-Mek 1.9% EC	abamectin	Supra Captan 80 WDG	captan	Apollo SC	clofentezine
Alias 240 SC	imidacloprid	Carzol SP	formetanate hydrochloride	Bioprotec CAF	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>
Cygon 480 Ag	dimethoate	Copper 53 W	tri-basic copper sulphate	Botran 75 W	dicloran
Decis 5 EC	deltamethrin	Dikar	mancozeb, dinocap	Bravo 500	chlorothalonil
Diazinon 500 E	diazinon	Endosulfan 50 W	endosulfan	Cabrio EG	pyraclostrobin
Diazinon 50 W	diazinon	Envidor	spirodiclofen	Calypto 480 SC	thiacloprid
Entrust 80 W	spinosad	Maestro 80 DF	captan	Confirm 240 F	tebufenozide
Furadan 480 F	carbofuran	Nustar	flusilazole	Copper Spray	copper from copper oxychloride
GF-120 NF	spinosad	Rimon 10 EC	novaluron	Dipel 2X DF	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>
Guthion 50 WSB	azinphosmethyl	Thiodan 4 EC	endosulfan	Dithane DG	mancozeb
Imidan 50 WP	phosmet	Thiodan 50 WP	endosulfan	Elevate 50 WDG	fenhexamid
Lagon 480 E	dimethoate	Thionex 50 WP	endosulfan	Equal 65 WP	dodine
Lannate	methomyl	Zolone Flo	phosalone	Ferbam 76 WDG	ferbam
Lorsban 50 W	chlorpyrifos			Flint 50 WG	trifloxystrobin
Malathion 25 W	malathion			Folpan 80 WDG	folpet
Malathion 500 E	malathion			Foray 48 BA	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>
Malathion 500 EC	malathion			Funginex DC	triforine
Matador 120 EC	cyhalothrin-lambda			Gavel 75 DF	zoxamide + mancozeb
Nexter	pyridaben			Indar 75 WSP	fenbuconazole
Orthene 75% SP	acephate			Intrepid 240 F	methoxyfenozide
Pounce	permethrin			Kanemite 15 SC	acequinocyl
Pyramite	pyridaben			Kelthane 50 W	dicofol
Ripcord 400 EC	cypermethrin			Kumulus DF	sulphur
Sevin XLR	carbaryl			Lance WDG	boscalid
Success 480 SC	spinosad			Manzate Pro-Stick	mancozeb
Sniper	azinphosmethyl			MilStop	potassium bicarbonate
Vydate	oxamyl			Mission 418 E	propiconazole
				Nova 40 W	myclobutanol
				Penncozeb 75 DF	mancozeb
				Polyram DF	metiram
				Pristine WG	boscalid + pyraclostrobin
				Ridomil Gold 480 SL	metalaxyl-m
				Ridomil Gold MZ	metalaxyl + mancozeb
				Ronilan EG	vinclozolin
				Rovral	iprodione
				Scala SC	pyrimethanil
				Scholar 50 WP	fludioxonil
				Senator 70 WP	thiophanate-methyl
				Serenade Max	<i>Bacillus subtilis</i>
				Sovran	kresoxim-methyl
				Switch 62.5 WG	cyprodinil + fludioxonil
				Tanos 50 DF	famoxadone + cymoxanil
				Topas 250 E	propiconazole
				Vanguard 75 WG	cyprodinil

Source: PMRA Environmental Assessment Division.

Buffer Zones

Leave a suitable buffer zone between the treatment area and adjacent sensitive areas. Buffer zones are areas left untreated to protect an adjacent sensitive area, aquatic system or natural habitat. Some pesticide labels provide specific buffer zones for spraying. Examples are provided in Table 9-5. *Examples of Buffer Zones for Pesticides Used in Publication 360*, on this page.

Adjacent sensitive areas include cultivated plants grown for human consumption, plants sensitive to

herbicide drift, trees or shrubs that may be damaged by herbicides leaching to roots, and areas where children play.

Aquatic systems include lakes, reservoirs, streams, creeks, ditches, marshes, wetlands, ponds, wellheads, commercial fishponds, etc. Buffer zones for saltwater habitat may vary and are present on the label.

Natural habitats include hedgerows, grasslands, shelterbelts, windbreaks, woodlots, vegetative strips, etc.

TABLE 9-5. Examples of Buffer Zones for Pesticides Used in Publication 360

Product	Buffer zone for freshwater aquatic systems		Buffer zone for natural habitat	
	Airblast sprayer	Boom or field sprayer	Airblast sprayer	Boom or field sprayer
Acramite 50 WS	2 m			
Actara 25 WG	Early season: less than 1 m depth: 4 m 1–3 m depth: 3 m greater than 3 m depth: 1 m	Early season: less than 1 m depth: 4 m 1–3 m depth: 3 m greater than 3 m depth: 1 m		
Admire 240 F	40 m	15 m		
Agri-Mek 1.9% EC	Early growth: 45 m Late growth: 35 m	30 m		
Alias 240 SC	40 m	15 m		
Aliette WDG	8 m	8 m		
Apogee	Early season: 4 m Late season: 2 m			
Assail 70 WP	30 m	20 m	10 m	2 m
Bravo 500	15 m	15 m		
Cabrio EG	42 m	31 m	2 m	2 m
Calypso 480 SC	Early season: less than 1 m depth: 30 m 1–3 m depth: 25 m greater than 3 m depth: 15 m Late season: less than 1 m depth: 20 m 1–3 m depth: 15 m greater than 3 m depth: 5 m	Early season: less than 1 m depth: 30 m 1–3 m depth: 25 m greater than 3 m depth: 15 m Late season: less than 1 m depth: 20 m 1–3 m depth: 15 m greater than 3 m depth: 5 m		
Confirm 240 F	15 m			
Decis 5 EC	15 m	15 m		
Elevate 50 WDG	7 m	7 m		
Entrust 80 W	Early season: 2 m Late season: 1 m			
Envirdor SC	2 m	2 m		
Flint 50 WG	Early season: 17 m Late season: 9 m	10 m	1 m	
Gavel 75 DF	35 m	25 m	10 m	5 m
Intrepid 240 F	10 m			

TABLE 9-5. Examples of Buffer Zones for Pesticides Used in Publication 360 (cont'd)

Product	Buffer zone for freshwater aquatic systems		Buffer zone for natural habitat	
	Airblast sprayer	Boom or field sprayer	Airblast sprayer	Boom or field sprayer
Kanemite 15 SC	Early season: less than 1 m depth: 15 m greater than 1 m depth: 5 m Late season: less than 1 m depth: 5 m greater than 1 m depth: 3 m	less than 1 m depth: 2 m greater than 1 m depth: 1 m		
Lance WDG	Early season: 5 m Late season: 2 m		Early season: 5 m Late season: 2 m	
Matador 120 EC	80 m	15 m		
Nexter	49 m			
Nova 40 W	15 m	15 m		
Nustar	5 m	5 m		
Orthene 75% SP	10 m	10 m		
Pounce	15 m	15 m		
Pristine WG	35 m	35 m	5 m	
Pyramite	49 m			
Rimon 10 EC	Early season: less than 1 m depth: 75 m 1-3 m depth: 70 m greater than 3 m depth: 60 m Late season: less than 1 m depth: 65 m 1-3 m depth: 60 m greater than 3 m depth: 50 m	Early season: less than 1 m depth: 75 m 1-3 m depth: 70 m greater than 3 m depth: 60 m Late season: less than 1 m depth: 65 m 1-3 m depth: 60 m greater than 3 m depth: 50 m		
Ripcord 400 EC	15 m	15 m		
Ronilan EG	15 m	15 m		
Scala SC	Early season: 10 m Late season: 5 m	1 m with cones or shrouds: 0 m		
Sovran	7 m	7 m	3 m	3 m
Switch 62.5 WG	less than 1 m depth: 2 m less than 2 m depth: 1 m greater than 3 m depth: 0 m	less than 1 m depth: 2 m less than 2 m depth: 1 m greater than 3 m depth: 0 m		
Success 480 SC	Early season: 2 m Late season: 1 m			
Tanos 50 DF	44 m	44 m		

Use this table for general guidelines, but always refer to the label for product-specific information.

Buffer zones for aerial application are not included in this table, but may be present on the label. Read the label and follow all safety precautions.

Pesticides Used on Fruit Crops in Ontario

TABLE 9-6. Pesticides Used on Fruit Crops in Ontario

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use ¹	Crop recommended registrations	Formulation ²	Guaranteed active	Ont. sch. ³	Registrant code ⁴
	abamectin	see AGRI-MEK 1.9% EC						
	acephate	see ORTHENE 75% SP						
	acequinocyl	see KANEMITE 15 SC						
	acetamiprid	see ASSAIL 70 WP						
27925	ACRAMITE 50 WS	bifenazate	a	apples, grapes	WSP	50 %	3	CRE
28408	ACTARA 25 WG	thiamethoxam	i	apples, pears	WDG	25%	2	SYZ
24094	ADMIRE 240 F	imidacloprid	i	apples, blueberries, peaches, nectarines	FI	240 g/L	3	BCZ
24551	AGRI-MEK 1.9% EC	abamectin	ai	apples, pears, raspberries, strawberries	EC	19 g/L	2	SYZ
28475	ALIAS 240 SC	imidacloprid	i	apples, blueberries	SC	240 g/L	3	MKA
24458	ALIETTE WDG	fosetyl al	f	apples, raspberries, strawberries	WDG	80%	2	BCZ
28042	APOGEE	prohexadione calcium	pgr	apples	WP	27.5%	3	BAZ
21035	APOLLO SC	clofentezine	a	apples, peaches, raspberries, strawberries	SC	500 g/L	2	MKA
27128	ASSAIL 70 WP	acetamiprid	i	apples, grapes, pears	WP	70%	3	DUQ
	azinphosmethyl	see GUTHION 50 WSB, SNIPER						
	<i>Bacillus subtilis</i>	see SERENADE MAX						
	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	see DIPEL 2X DF, FORAY 48BA, BIOPROTEC CAF						
8024	BARTLETT WAXED MOUSE BAIT	zinc phosphide	r	orchards	pellets	2%	2	BAT
	bifenazate	see ACRAMITE 50 WS						
26854	BIOPROTEC CAF	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	i	apples, apricots, sour cherries, pears, raspberries	L	12.7 BIU/L	2	AFG
	boscalid	see LANCE WDG						
	boscalid + pyraclostrobin	see PRISTINE WG						
8772	BOTRAN 75 W	dicloran	f	peaches	WP	75%	3	GOW

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² Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; EG – water dispersable granule; FL – flowable; GR – granule; L – liquid; SC – soluble concentrate; SN – solution; SU – suspension (flowable); WDG – water dispersable granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

³ See Table 9-8. Ontario's Pesticide Classification Schedules, on page 206.

⁴ Registrant or manufacturer's code: See Table 9-9. Pest Control Product Companies, on page 207.

TABLE 9-6. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME * Common name or active ingredient	Use ¹	Crop recommended registrations	Formulation ²	Guaranteed active	Ont. sch. ³	Registrant code ⁴
15723	BRAVO 500 chlorothalonil	f	blueberries, cherries, peaches, strawberries	FL	500 g/L	3	SYZ
19421	BUSAN 1020 metam sodium	n,f	orchards (before planting)	L	33%	3	BUL
27323	CABRIO EC pyraclostrobin	f	blueberries, cherries, strawberries	EG	20%	3	BAZ ENG
28429	CALYPSO 480 SC thiacloprid	i	apples, pears	SC	480g/L	2	BCZ
	captan		see Supra CAPTAN 80 WDG, MAESTRO 80 DF				
	carbaryl		see SEVIN XLR				
	carbofuran		see FURADAN 480 F				
11144	CARZOL SP formetanate hydrochloride	a,i	apples, peaches, pears	SP	92%	5	GOW BAT
	chlorophacinone		see ROZOL, GROUND FORCE				
	chloropicrin		see CHLOROPICRIN 100				
	chlorothalonil		see BRAVO 500				
	chlorpyrifos		see LORSBAN 50 W				
	clofentezine		see APOLLO SC				
25863	CHLOROPICRIN 100 chloropicrin	f,n	raspberries, strawberries (before planting)	L	99%	5	HND
24503	CONFIRM 240 F tebufenozide	i	apples	FL	240 g/L	2	DWE
9934	COPPER 53 W tri-basic copper sulphate	b, f	apples, currants, gooseberries, strawberries	WP	53%	2	UAG
19146	COPPER SPRAY copper from copper oxychloride	f	filberts, hazelnuts, walnuts	WP	50%	3	UAG
25651	CYGON 480-AC dimethoate	i	blueberries, strawberries	EC	480 g/L	2	CUI
	cyhalothrin lambda		see MATADOR 120 EC				
	cymoxanil + famoxadone		see TANOS 50 DF				
	cypermethrin		see RIPCORD 400 EC				
	cyprodinil		see VANGARD 75 WG				
	cyprodinil + fludioxonil		see SWITCH 62.5 WG				
22478	DECIS 5 EC deltamethrin	i	apples, blueberries, peaches, pears, strawberries	EC	50 g/L	2	BCZ
	deltamethrin		see DECIS 5 EC				

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⁴ Registrant or manufacturer's code: See Table 9-9, Pest Control Product Companies, on page 207.

TABLE 9-6. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use ¹	Crop recommended registrations	Formulation ²	Guaranteed active	Ont. sch. ³	Registrant code ⁴
	diazinon	see DIAZINON 50 W, DIAZINON 500 E						
11889	DIAZINON 500 E	diazinon	i	apples, currants, raspberries	EC	500 g/L	2	UAG
19576	DIAZINON 50 W	diazinon	i	apples, cherries, currants, grapes, plums, raspberries	WP	50%	2	UAG
	dicloran	see BOTRAN 75 W						
	dicofol	see KELTHANE 50 W						
	dichloropropene	see TELONE II						
	dichloropropene + chloropicrin	see TELONE C-17						
10495	DIKAR	mancozeb + dinocap	a,f	apples, grapes, pears	WP	72% + 4.6%	3	DWE
	dimethoate	see CYGON 480-AG, LAGON 480 E						
26508	DIPEL 2X DF	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	i	apples, apricots, blueberries, cherries, filberts, hazelnuts, pecans, pears, raspberries, sweet chestnuts, walnuts	DF	32 biu/kg	3	VBC
	diphacinone	see RAMIK BROWN						
20553	DITHANE DG	mancozeb	f	apples	DG	75%	3	DWE
	dodine	see EQUAL 65 WP						
25900	ELEVATE 50 WDG	fenhexamid	f	blueberries, cherries, currants, grapes, peaches, raspberries, strawberries	WDG	50%	2	TOA
	endosulfan	see THIODAN 4 EC, THIODAN 50 WP, THIONEX 50 WP						
27825	ENTRUST 80 W	spinosad	i	apples, apricots, cherries, pears, plums	W	80%	2	DWE
28051	ENVIDOR 240 SC	spirodiclofen	i	apples, apricots, cherries, grapes, peaches, pears	SC	240 g/L	3	BCZ
15608	EQUAL 65 WP	dodine	f	pears, sour cherries, strawberries	WP	65%	3	NOC
	famoxadone + cymoxanil	see TANOS 50 DF						
	fenbuconazole	see INDAR WSP						

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TABLE 9-6. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME * Common name or active ingredient	Use ¹	Crop recommended registrations	Formulation ²	Guaranteed active	Ont. sch. ³	Registrant code ⁴
	fenhexamid		see ELEVATE 50 WDG				
	ferbam		see FERBAM 76 WDG				
20136 20536	FERBAM 76 WDG	ferbam	f apples, blueberries, cherries, currants, grapes, peaches, raspberries	WDG	76%	3	UAG TAM
	ferric phosphate		see SLUGGO				
27529	FLINT 50 WG	trifloxystrobin	f apples, grapes, pears	WDG	50%	2	BCZ
	fludioxonil		see SCHOLAR 50 WP				
	fludioxonil + cyprodinil		see SWITCH 62.5 WG				
	flusilazole		see NUSTAR				
27733	FOLPAN 80 WDG	folpet	f grapes, strawberries	WDG	80%	3	UAG, MKA
	folpet		see FOLPAN 80 WDG				
24978	FORAY 48BA	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	i apples, pears, raspberries	L	12.7 biu/L	3	VBC
	formetanate hydrochloride		see CARZOL SP				
	fosetyl al		see ALIETTE WDG				
27686	FUNGINEX DC	triforine	f blueberries, cherries, peaches, plums, saskatoons	DC	195 g/L	2	ENG
10828	FURADAN 480 F	carbofuran	i strawberries	FL	480 g/L	5	BCZ
26842	GAVEL 75 DF	zoxamide + mancozeb	f grapes	DF	8.4% + 66.7%	3	DWE
28336	GF-120 NF	spinosad	i blueberries, cherries	L	0.02%	3	DWE
20239	GROUND FORCE	chlorophacinone	r orchards	pellets	0.005%	6	LPH, UAG
13245	GUARDSMAN COPPER OXYCHLORIDE 50	copper from copper oxychloride	f filberts, hazelnuts	WP	50%	2	VAR
23370	GUARDSMAN DORMANT OIL SPRAY	mineral oil	f blueberries	EC	98.5%		VAR
21374	GUTHION 50 WSB	azinphosmethyl	i apples, apricots, cherries, grapes, peaches, pears, plums, raspberries	WSP	50%	5	BCZ
	imidacloprid		see ADMIRE 240 F, ALIAS 240 SC				

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TABLE 9-6. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use ¹	Crop recommended registrations	Formulation ²	Guaranteed active	Ont. sch. ³	Registrant code ⁴
23006	IMIDAN 50 WP	phosmet	i	apples, blueberries, grapes, sour cherries, peaches, pears, plums	WSP	50%	3	GOW
27294	INDAR 75 WSP	fenbuconazole	f	apricots, cherries, peaches, plums	WSP	75%	5	DWE
27786	INTREPID 240 F	methoxyfenozide	i	apples, pears	FL	240 g/L	2	DWE
	iprodione	see ROVRAL						
26981	ISOMATE M 100	pheromone, oriental fruit moth	md	apples, apricots, peaches, pears	DIS	95.2%	3	PBC
27339	ISOMATE M ROSSO	pheromone, oriental fruit moth	md	apples, apricots, peaches, pears	DIS	95.2%	4	PBC
27525	ISOMATE GBM PLUS	pheromone, grape berry moth	md	grapes	DIS	91.1%	6	PBC
28641	KANEMITE 15 SC	acequinocyl	a	apples, pears	SC	15.8%	2	TOA
	kaolin	see SURROUND WP						
24707	KELTHANE 50 W	dicofol	a	apples, apricots, cherries, grapes, peaches, pears, plums, strawberries, raspberries	WP	50%	2	DWE
	kresoxim-methyl	see SOVRAN						
18836	KUMULUS DF	sulphur	f	apples, sour cherries, grapes, Saskatoons	DF	80%	6	BAZ, ENG
9382	LAGON 480 E	dimethoate	i	blueberries, filberts, hazelnuts	EC	480 g/L	2	UAG
27495	LANCE WDG	boscalid	f	apricots, blueberries, cherries, currants, grapes, peaches, plums, raspberries, strawberries	WDG	70%	5	BAZ
10868	LANNATE	methomyl	i	apples	WSP	90%	5	DUQ
16465	LIME SULPHUR	calcium polysulphide	f	blueberries, raspberries	SN	22%	3	UAG
20944	LORSBAN 50 W	chlorpyrifos	i	peaches	WP	50%	2	DWE

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TABLE 9-6. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use ¹	Crop recommended registrations	Formulation ²	Guaranteed active	Ont. sch. ³	Registrant code ⁴
26408	MAESTRO 80 DF	captan	f	apples, apricots, blueberries, cherries, grapes, peaches, pears, plums, raspberries, strawberries	DF	80%	2	TOA
	malathion	see MALATHION 25 W, MALATHION 500 E, MALATHION 500 EC						
14656	MALATHION 25 W	malathion	i	apples, blueberries, currants, raspberries, strawberries	WP	25%	3	UAG
4709	MALATHION 500 E	malathion	i	grapes	EC	500 g/L	3	UAG
4282	MALATHION 500 EC	malathion	i	non-bearing nut trees	EC	500 g/L	3	SSX
	mancozeb	see DIKAR, MANZATE PRO-STICK DF, DITHANE DG, GAVEL 75 DF, PENNCOZEB 75 DF						
	mancozeb + metalaxyl	see RIDOMIL GOLD MZ 68 WP						
28217	MANZATE PRO-STICK	mancozeb	f	apples	DF	75%	2	DUQ
24984	MATADOR 120 EC	cyhalothrin-lambda	i	apples, peaches, pears, strawberries	EC	120 g/L	5	SYZ
13975	MERTECT SC	thiabendazole	f	apples, pears	SU	500 g/L	3	SYZ
	metalaxyl + mancozeb	see RIDOMIL GOLD MZ 68 WP						
	metalaxyl-m and s-isomers	see RIDOMIL GOLD 480 SL						
	metam sodium	see VAPAM, BUSAN 1020						
	methomyl	see LANNATE						
	methoxyfenozide	see INTREPID 240 F						
	metiram	see POLYRAM DF						
14653	MICROSCOPIC SULPHUR	sulphur	f	apples, currants, grapes, peaches, plums	WP	92%	6	UAG
873	MICROSCOPIC WETTABLE SULPHUR	sulphur	f	apples, currants, grapes, peaches, plums	WP	92%	6	BAT
28095	MILSTOP	potassium bicarbonate	f	grapes	WP	85%	3	BWI
	mineral oil	see SUPERIOR 70 OIL						

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TABLE 9-6. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME * Common name or active ingredient	Use ¹	Crop recommended registrations	Formulation ²	Guaranteed active	Ont. sch. ³	Registrant code ⁴
28016	MISSION 418 EC	f	apricots, blueberries, cherries, peaches, plums, saskatoons	EC	418 g/L	2	MKA
	myclobutanil		see NOVA 40 W				
25135	NEXTER	a.i	apples, pears, peaches, grapes, raspberries, sour cherries, strawberries	WP	75%	2	GOW
22399	NOVA 40 W	f	apples, cherries, grapes, peaches, saskatoons, strawberries	WSP	40%	2	DWE
	novaluron		see RIMON 10 EC				
25547	NUSTAR	f	apples	DF	20%	2	DUQ
14225	ORTHENE 75% SP	i	saskatoons	SP	75%	2	TOA
	oxamyl		see VYDATE				
25397	PENNCOZEB 75 DF	f	apples	WDG	75%	3	CRA
	permethrin		see POUNCE				
	pheromone		see ISOMATE GBM, ISOMATE M-ROSSO, ISOMATE M-100, ISOMATE GBM PLUS				
	phosalone		see ZOLONE FLO				
	phosmet		see IMIDAN				
20087	POLYRAM DF	f	apples, grapes	WDG	80%	3	BAZ, ENG
	potassium bicarbonate		see MILSTOP				
16565	POUNCE	i	apples, grapes, peaches, pears	EC	384 g/L	3	UAG, BCZ
27985	PRISTINE WG	f	apricots, blueberries, cherries, currants, nectarines, peaches, plums, raspberries, strawberries	WG	25.2% + 12.8%	5	BAZ
	propiconazole		see MISSION 418 EC, TOPAS 250 E				
	pyraclostrobin		see CABRIO EG				
	pyraclostrobin + boscalid		see PRISTINE WG				
25135	PYRAMITE	a.i	apples, sour cherries, grapes, pears, peaches, raspberries, strawberries	WP	75%	2	GOW

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TABLE 9-6. Pesticides Used on Fruit Crops in Ontario (cont'd)

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	pyridaben	see PYRAMITE, NEXTER						
	pyrimethanil	see SCALA SC						
11670	RAMIK BROWN	diphacinone	r	orchards	pellets	0.005%	6	UAG, HOK
28474	RIDOMIL GOLD 480 SL	metalaxyl-m + s-isomers	f	apples, blueberries, raspberries, strawberries	SN	480 g/L	2	SYZ
25379	RIDOMIL GOLD MZ 68 WP	metalaxyl + mancozeb	f	grapes	WP	4% + 64%	2	SYZ
28515	RIMON 10 EC	novaluron	i	apples	EC	10%	5	MKA
15738	RIPCORD 400 EC	cypermethrin	i	apples, grapes, peaches, pears, strawberries	EC	407 g/L	2	BAZ
24894	RONILAN EG	vinclozolin	f	strawberries	DG	50%	3	BAZ
15213	ROVRAL	iprodione	f	apricots, cherries, grapes, peaches, plums, raspberries, strawberries	WP	500 g/kg	3	BCZ
13729	ROZOL	chlorophacinone	r	orchards	pellets	0.005%	6	UAG, LPH
28011	SCALA SC	pyrimethanil	f	apples, pears, grapes, strawberries	SC	400 g/L	5	BCZ
28568	SCHOLAR 50 WP	fludioxonil	f	apples, apricot, cherries, pears, peaches, plums, nectarines	WSP	50%	2	SYN
25343	SENATOR 70 WP	thiophanate-methyl	f	raspberries	WP	70%	3	ENG
28549	SERENADE MAX	<i>Bacillus subtilis</i>	f	blueberries, currants, gooseberries, grapes, raspberries, strawberries	WP	14.6%	3	AAJ
27876	SEVIN XLR	carbaryl	i	apples, apricots, blueberries, cherries, grapes, peaches, pears, plums, raspberries	SU	42.8%	2	BCZ
27096	SLUGGO	ferric phosphate	s	grapes, strawberries	GR	0.76%	6	ENG

* Mention of a BRAND or TRADE name does not constitute a guarantee of warranty of the product by the Ontario Crop Protection Committee. All TRADE NAMES are capitalized.

¹ a – acaricide, miticide; b – bactericide; f – fungicide; i – insecticide; n – nematocide; r – rodenticide; md – mating disrupter; s – slug bait.

² Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; EG – water dispersable granule; FL – flowable; GR – granule; L – liquid; SC – soluble concentrate; SN – solution; SU – suspension (flowable); WDG – water dispersable granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

³ See Table 9-8, *Ontario's Pesticide Classification Schedules*, on page 206.

⁴ Registrant or manufacturer's code: See Table 9-9, *Pest Control Product Companies*, on page 207.

TABLE 9-6. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use ¹	Crop recommended registrations	Formulation ²	Guaranteed active	Ont. sch. ³	Registrant code ⁴
23323	SNIFER	azinphosmethyl	i	apples, apricots, cherries, grapes, peaches, pears, raspberries, plums	WSP	50%	5	UAG
26257	SOVRAN	kresoxim-methyl	f	apples, pears, grapes	WDG	50%	3	ENG, BAZ
	spinosad	see SUCCESS 480 SC, ENTRUST 80 W, GF-120 NF						
	spirodiclofen	see ENVIDOR 240 SC						
10305	STREPTOMYCIN 17	streptomycin sulfate	b	apples, pears	WP	25.2%	3	UAG
	streptomycin sulfate	see STREPTOMYCIN 17						
26835	SUCCESS 480 SC	spinosad	i	apples, apricots, cherries, grapes, pears, plums	SC	480 g/L	3	DWE
	sulphur	see KUMULUS, MICROSCOPIC SULPHUR, MICROSCOPIC WETTABLE SULPHUR, LIME SULPHUR						
9542 14981	SUPERIOR 70 OIL	mineral oil	a,i	apples, apricots, peaches, pears, plums, sour cherries, saskatoons	L	99%	6	BAT, UAG
24613	SUPRA CAPTAN 80 WDG	captan	f	apples, apricots, blueberries, grapes, peaches, pears, plums, raspberries, cherries, strawberries	WDG	80%	2	UAG
27469	SURROUND WP	kaolin	i	apples, grapes, pears, walnuts	WP	95%	6	ENG
28189	SWITCH 62.5 WG	cyprodinil + fludioxonil	f	blueberries, strawberries, raspberries	WG	37.5% + 25%	2	SYN
27435	TANOS 50 DF	famoxadone + cymoxanil		raspberries	DF	25% + 25%	2	DUQ
	tebufenozide	see CONFIRM 240 F						
16324	TELONE C-17	dichloropropene + chloropicrin	f,n	before planting orchards, raspberries, strawberries	L	78% + 16.5%	2	DWE
15893	TELONE II	dichloropropene	n	before planting orchards, raspberries, strawberries	L	94%	2	DWE

* Mention of a BRAND or TRADE name does not constitute a guarantee of warranty of the product by the Ontario Crop Protection Committee. All TRADE NAMES are capitalized.

¹ a – acaricide, miticide; b – bactericide; f – fungicide; i – insecticide; n – nematocide; r – rodenticide; md – mating disrupter; s – slug bait.

² Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; EG – water dispersable granule; FL – flowable; GR – granule; L – liquid; SC – soluble concentrate; SN – solution; SU – suspension (flowable); WDG – water dispersable granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

³ See Table 9-8. Ontario's Pesticide Classification Schedules, on page 206.

⁴ Registrant or manufacturer's code: See Table 9-9. Pest Control Product Companies, on page 207.

TABLE 9-6. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use ¹	Crop recommended registrations	Formulation ²	Guaranteed active	Ont. sch. ³	Registrant code ⁴
	thiabendazole	see MERTECT SC						
	thiacloprid	see CALYPSO 480 SC						
	thiamethoxam	see ACTARA 25 WG						
15747	THIODAN 4 EC	endosulfan	i	apricots, peaches, plums, strawberries	EC	400 g/L	2	BCZ
15821	THIODAN 50 WP	endosulfan	i	apples, apricots, cherries, grapes, peaches, pears, plums, strawberries	WP	50%	2	BCZ
14617	THIONEX 50 W	endosulfan	i	apples, apricots, cherries, grapes, peaches, pears, plums, strawberries	WP	50%	2	UAG
	thiophanate methyl	see SENATOR 70 WP						
24030	TOPAS 250 E	propiconazole	f	apricots, blueberries, cherries, peaches, plums, saskatoons, strawberries	EC	250 g/L	2	ENG
	tri-basic copper sulphate	see COPPER 53 W						
	trifloxystrobin	see FLINT WG						
	triforine	see FUNGINEX DC						
25509	VANGARD 75 WG	cyprodinil	f	apples, apricots, grapes, peaches, plums	WDG	75%	2	ENG
6453	VAPAM	metam sodium	f,h, n	berry crops, orchards, (before planting)	SN	380 g/L	3	UAG, AMV
	vinclozolin	see RONILAN EG						
17995	VYDATE	oxamyl	i,n	apples, raspberries	L	240 g/L	5	DUQ
17983	ZOLONE FLO	phosalone	i	apples, cherries	FL	500 g/L	2	CUI
	zoxamide + mancozeb	see GAVEL 75 DF						

* Mention of a BRAND or TRADE name does not constitute a guarantee of warranty of the product by the Ontario Crop Protection Committee. All TRADE NAMES are capitalized.

¹ a – acaricide, miticide; b – bactericide; f – fungicide; i – insecticide; n – nematocide; r – rodenticide; md – mating disrupter; s – slug bait.

² Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; EG – water dispersable granule; FL – flowable; GR – granule; L – liquid; SC – soluble concentrate; SN – solution; SU – suspension (flowable); WDG – water dispersable granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

³ See Table 9-8, *Ontario's Pesticide Classification Schedules*, on page 206.

⁴ Registrant or manufacturer's code: See Table 9-9, *Pest Control Product Companies*, on page 207.

TABLE 9-7. Thinners and Growth Regulators Used on Fruit Crops in Ontario

Registration no.	BRAND or TRADE NAME*	Common name or active ingredient	Use ¹	Guaranteed % (active unless stated)	Formulation ²	Ont. sch. ³	Registrants code ⁴
24593	ACCEL	N-(phenylmethyl)-1 H-purine-6-amine gibberellins A ₄ A ₇	PGR, TH	1.8% 0.18%	SN	3	VBC
13167	AMID-THIN	1-naphthaleneacetamide	PGR, TH	8.3%		6	AMV, UAG
28042	APOGEE	prohexadione calcium	PGR	27.5 %	WP	3	BAZ
11580	ETHREL	ethephon	PGR	240 g/L	L	6	BCZ
27653	FALGRO	gibberellic acid	PGR	1.0 g/tablet	tablets	6	NOC
14630	FRUITONE N	1-naphthaleneacetic acid	PGR, TH	3.1%		3	AMV, UAG
16636	PROMALIN	benzyladenine gibberellins	PGR	1.8% BA 1.8% GA	SN	3	VBC
27469	SURROUND WP	kaolin clay	CP	95%	WP	6	ENG
25609	ReTAIN	aminoethoxy vinyl glycine hydrochloride	PGR	15%	SP	2	VBC

* Mention of a BRAND or TRADE name does not constitute a guarantee of warranty of the product by the Ontario Crop Protection Committee. All TRADE NAMES are capitalized.

¹ PGR – plant growth regulator; TH – thinner; CP – crop protectant.

² L – liquid; SP – soluble powder; SN – solution; WP – wettable powder.

³ See Table 9-8. Ontario Pesticide Classification Schedules, on this page.

⁴ Registrant or manufacturer's code: See Table 9-9. Pest Control Product Companies, on page 207.

TABLE 9-8. Ontario's Pesticide Classification Schedules

Schedule	Human and/or Environmental Health Criteria*	For use according to label directions by:				
		Licensed Exterminator	Certified Grower	Technician/ Trainee	Trained Assistant	Property Owner or Tenant
1	Very Toxic Very Persistent	✓ (under permit)	✓ (under permit)			
5	Very Toxic Very Persistent	✓ (aerial application under permit)	✓		✓ (under supervision)	
2	Toxic Persistent	✓	✓	✓ (under supervision)	✓ (under supervision)	✓ (aquatic herbicides, under permit)
3	Moderately Toxic Moderately Persistent	✓	✓	✓ (under supervision)	✓	✓
4	Low Toxicity Low Persistence	✓	✓	✓ (under supervision)	✓	✓
6	Low Toxicity Low Persistence (larger size container)	✓	✓	✓ (under supervision)	✓	✓

* More detailed information on classification criteria is outlined in the OPAC guidelines for classification of pesticide products available at www.opac.gov.on.ca.

TABLE 9-9. Pest Control Product Companies

Code*	Registrant or agent	Website	Contact number
AAJ	AgraQuest	www.agraquest.com	See UAG
AFG	AEF Global Inc.	www.aefglobal.com	418-838-4441
AMV	AMVAC Chemical Corporation	www.ecozin.com (U.S. website)	323-264-3910
BAT	Bartlett, N.M. Inc.	www.bartlett.ca	1-800-263-1287
BAZ	BASF Canada Inc.	www.agsolutions.ca	1-877-371-2273
BCZ	Bayer CropScience	www.bayercropscience.ca	1-877-938-3737
BWI	Bioworks	www.bioworksbiocontrol.com	585-641-0581
BUL	Buckman Laboratories of Canada	www.buckman.com	450-424-4404
CRA	Cerexagri Inc. (Atofina Canada)	www.cerexagri.com	905-827-9841
CRE	Crompton Co/Cie	www.cromptoncorp.com	1-800-350-1745
CUI	Cheminova Canada Inc.	www.cheminova.com	1-888-316-6260
DUQ	E.I. du Pont Canada Company	www.dupont.ca/ag	1-800-667-3925
DWE	Dow AgroSciences Canada	www.dowagro.com	1-800-667-3852
ENG	Engage Agro Corp	www.engageagro.com	1-866-613-3336
GOW	Gowan Company	www.gowanco.com	1-800-883-1844
GRN	Griffin Corp	www.dupont.ca/ag	1-800-667-3925
HND	Hendrix and Dail Inc.	www.hendrixanddail.com	
HOK	Hacco Inc.	www.hacco.com (U.S. website)	920-326-2461
LPH	Lipha Tech	www.liphatech.com (U.S. website)	414-351-1476
MKA	Makhteshim-Agan	www.manainc.ca	416-233-1496
NOC	Norac Concepts	www.noracconcepts.com	519-821-3110
PBC	Pacific Biocontrol	www.pacificbiocontrol.com (U.S. website)	360-571-2247
SSX	Scotts Canada Ltd	www.scottscanada.ca	1-800-668-5669
SYZ	Syngenta Crop Protection	www.syngenta.ca	1-877-964-3682
TOA	Arysta LifeScience	www.arystalifescience.ca	1-866-761-9397 519-766-1117
UAG	United Agri Products Canada Inc.	www.uap.ca	1-800-265-4624
VAR	Univar	www.univarcanada.com	1-800-265-7671
VBC	Valent Biosciences	www.valent.com	1-800-682-5368

The three-letter manufacturers' codes represent the codes listed in Table 9-6. *Pesticides Used on Fruit Crops in Ontario*, on page 196 and Table 9-7. *Thinners and Growth Regulators Used on Fruit Crops in Ontario*, on page 206.
For Canadian labels, contact the registrant or search the PMRA website at www.pmr-arla.gc.ca/english/main/search-e.html.

10. Appendices

APPENDIX A: Suppliers of Pest Monitoring Equipment and Biological Control Agents

This is a partial list of suppliers of IPM monitoring equipment, which includes weather monitoring equipment, pest monitoring supplies and biological control agents. For a more extensive list of beneficial insects and mite suppliers, see the OMAFRA website at ontario.ca/crops.

Company	Address	Phone/Fax	E-mail/Website	Products
Biobest Canada Ltd.	2020 Mersea Rd. #3 R.R. #4 Leamington, ON N8H 3V7	Tel: 519-322-2178 Fax: 519-322-1271 Toll-free fax: 1-888-472-0708	info@biobest.ca www.biobest.ca	beneficial insects, mites, nematodes, insect traps and pheromones
Cooper Mill Ltd.	R.R. # 3 Madoc, ON K0K 2K0	Tel: 613-473-4847 Fax: 613-473-5080	ipm@coopermill.com www.coopermill.com	pheromone lures and traps
Gempler's	1210 Fourier Dr. Suite 150 Madison, WI 53717	Tel: 1-800-382-8473 Fax: 1-800-551-1128	www.gemplers.com	weather monitoring equipment pheromone lures and traps apple maggot spheres tangle trap magnifiers tally counters
Great Lakes IPM	10220 Church Rd. NE Vestaburg, MI 48891	Tel: 989-268-5693 Fax: 989-268-5311	glipm@nethawk.com www.greatlakesipm.com	apple scab monitoring equipment pheromone lures and traps apple maggot spheres tangle trap magnifiers tally counters insect sweep nets field diagnostic equipment
Koppert Canada Ltd.	50 Ironside Cres. #2 Scarborough, ON M1X 1G4	Tel: 416-291-0040 Fax: 416-291-0902	pgoodspeed@koppert.ca www.koppert.com	beneficial insects, mites
Natural Insect Control	R.R. # 2 Stevensville, ON L0S 1S0	Tel: 905-382-2904 Fax: 905-382-4418	nic@niagara.com www.naturalinsectcontrol.com	beneficial insects, mites and nematodes pheromone lures and traps mating disruption devices bird houses
N.M. Bartlett Inc.	4509 Bartlett Rd. Beamsville, ON L0R 1B1	Tel: 905-563-8261 Fax: 905-563-7882	info@bartlett.ca www.bartlett.ca	pheromone lures and traps mating disruption devices
Phero Tech Inc.	7572 Progress Way Delta, BC V4G 1E9	Tel: 604-940-9944 Fax: 604-940-9433	sales@pherotech.com www.pherotech.com	pheromone lures and traps
Plant Products Co. Ltd.	314 Orenda Rd. E. Brampton, ON L6T 1G1	Tel: 1-800-387-2449 Fax: 905-793-9632	sales@plantprod.com www.plantprod.com	beneficial insects and mites magnifiers

APPENDIX A: Suppliers of Pest Monitoring Equipment and Biological Control Agents (cont'd)

Company	Address	Phone/Fax	E-mail/Website	Products
Solida Distributors	480 rue St-Antoine St. Ferreol-les-Neiges, QC G0A 3R0	Tel: 418-826-0900 Fax: 418-826-0901	solida@clic.net	pheromone traps and lures tangle trap magnifiers tally counters apple maggot spheres
Warwick Orchards and Nursery	R.R. # 8 Watford, ON N0M 2S0	Tel: 519-849-6730 Fax: 519-849-6731	warwick@xcelco.on.ca	dewit leaf wetness sensor

APPENDIX B: Safety Supply Companies

Ask safety supply companies for help to select protective clothing and personal protective equipment.

Safety Supply Companies in Ontario Providing Protective Clothing and Personal Protective Equipment

3-M Canada Company	Occupational Health and Environmental Safety Box 5757 London, ON N6A 4T1	Tel: 519-452-6165 Toll-free: 1-800-364-3577 Fax: 519-452-4660
Acklands Grainger	90 W. Beaver Creek Rd. Richmond Hill, ON L4B 1E7	Tel: 905-731-5516 Toll-free: 1-800-668-8989 Fax: 905-731-2798
Aearo Canada	6889 Rexwood Rd. Mississauga, ON L4V 1R2	Tel: 905-795-0700 Toll-free: 1-800-387-4304 Fax: 905-564-5250
Dupont Personal Protection	20 Ryan Pl. Brantford, ON N3S 7S1	Tel: 519-752-4369 Toll-free: 1-800-387-9326 Fax: 519-752-2161
Dutch Industries "Protect-Air Cab Filter"	Huron Tractor, P.O. Box 1300 Exeter, ON N0M 1S3	Tel: 519-235-1115 Fax: 519-235-1939
HAMISCO	3392 Wonderland Rd. London, ON N6L 1A8	Tel: 519-652-9800 Toll-free: 1-800-668-9800 Fax: 519-652-9661
Levitt-Safety (Eastern) Ltd.	2872 Bristol Circle Oakville, ON L6H 5T5	Tel: 905-829-3299 Toll-free: 1-800-668-6153 Fax: 905-829-2919
Mitt & Robe Co. Ltd.	751 Norfolk St. N. Simcoe, ON N3Y 3R6	Tel: 519-428-4050 Toll-free: 1-877-893-6565 Fax: 519-428-5142
MSA Canada	2800 Skymark Ave., Unit 33 Mississauga, ON L4W 5A6	Tel: 905-602-0338 Toll-free: 1-800-267-0672 Fax: 905-238-4151
Plant Products Co. Ltd.	314 Orenda Rd. Brampton, ON L6T 1G1	Tel: 905-793-7000 Toll-free: 1-800-387-2449 Fax: 905-793-9632
Safety Express	4060B Sladeview Cres., Unit 2 Mississauga, ON L5L 5Y5	Tel: 905-608-0111 Toll-free: 1-800-465-3898 Fax: 905-608-0091
The St. George Company (Suppliers of Kasco Helmets)	20 Consolidated Dr., P.O. Box 430 Paris, ON N3L 3T5	Tel: 519-442-2046 Toll-free: 1-800-461-4299 Fax: 519-442-7191

APPENDIX C: Accredited Soil-Testing Laboratories in Ontario

The following labs are accredited to perform soil tests for pH, buffer pH, potassium, phosphorus, magnesium and nitrate-nitrogen on Ontario soils.

Laboratory Name	Address	Telephone/Fax/E-mail	Contact
A & L Canada Laboratories East Inc. Website: www.alcanada.com	2136 Jetstream Rd. London, ON N5V 3P5	Tel: 519-457-2575 Fax: 519-457-2664 E-mail: aginfo@alcanada.com	Mr. Greg Patterson Mr. Ian McLachlin
Accutest Laboratories Website: www.accutestlabs.com	146 Colonnade Rd., Unit #8 Nepean, ON K2E 7Y1	Tel: 613-727-5692 Fax: 613-727-5222 E-mail: phaulena@accutestlabs.com	Mrs. Lorna Wilson Mr. Peter Haulena
Agri-Food Laboratories Website: www.agtest.com	503 Imperial Rd., Unit #1 Guelph, ON N1H 6T9	Tel: 519-837-1600 Toll-free: 1-800-265-7175 Fax: 519-837-1242 E-mail: lab@agtest.com	Mr. Dale Cowan
Brookside Laboratories, Inc.	301 South Main St. New Knoxville, Ohio, US 45871	Tel: 419-753-2448 Fax: 419-753-2949 E-mail: nfisher@blinc.com	Ms. Nicole Fisher Mr. Mark Flock
Soil and Nutrient Laboratory (Formerly Analytical Services, Land Resource Science)	University of Guelph 95 Stone Rd. W. P.O. Box 3650 Guelph, ON N1H 8J7	Tel: 519-767-6226 Fax: 519-767-6240 E-mail: nschrier@lsd.uoguelph.ca	Mr. Nick Schrier
Stratford Agri Analysis (Daco Animal Nutrition) Website: www.stratfordagri.com	1131 Erie St. P.O. Box 760 Stratford, ON N5A 6W1	Tel: 519-273-4411 Toll-free: 1-800-323-9089 Fax: 519-273-2163 E-mail: info@stratfordagri.com	Dr. Jim Brimner
There is no official accreditation in Ontario for tissue analysis but all the accredited soil-testing labs are monitored for proficiency on tissue analyses.			

APPENDIX D: Diagnostic Services

Samples for disease diagnosis, insect or weed identification, nematode counts and *Verticillium* testing can be sent to:

Pest Diagnostic Clinic
Laboratory Services Division
University of Guelph
95 Stone Rd. W.
Guelph, ON N1H 8J7
Tel: 519-767-6256
Fax: 519-767-6240
E-mail: pdclsd@uoguelph.ca

Payment must accompany samples at the time of submission. Submission forms are available at www.uoguelph.ca/pdc.

Fee schedule

To obtain information on the fee schedule, visit www.uoguelph.ca/pdc or phone the Pest Diagnostic Clinic.

How to Sample for Nematodes

Soil

When to Sample

Soil and root samples can be taken at any time of the year that the soil is not frozen. In Ontario, nematode soil population levels are generally at their highest in May and June, and again in September and October.

How to Sample Soil

Use a soil sampling tube, trowel or narrow-bladed shovel to take samples. Sample soil to a depth of 20–25 cm (8–10 in.). If the soil is bare, remove the top 2 cm (1 in.) prior to sampling. A sample should consist of 10 or more subsamples combined. Mix well. Then take a sample of ½–1 L (1 pint–1 quart) from this. No one sample should represent more than 2.5 ha (6.25 ac). Mix subsamples in a clean pail or plastic bag.

Sampling Pattern

If living crop plants are present in the sample area, take samples within the row and from the area of the feeder root zone (with trees, this is the drip line).

Number of Subsamples

Based on the total area sampled:

500 m ² (5,400 ft ²)	10 subsamples
500 m ² –0.5 ha (5,400 ft ² –1.25 ac)	25 subsamples
0.5 ha–2.5 ha (1.25–6.25 ac)	50 subsamples

Roots

From small plants, sample the entire root system plus adhering soil. For large plants, 10–20 g (½–1 oz.) dig fresh weight from the feeder root zone and submit.

Problem areas

Take soil and root samples from the margins of the problem area where the plants are still living. If possible, also take samples from healthy areas in the same field. If possible, take both soil and root samples from problem and healthy areas in the same field.

Sample handling

Soil Samples

Place in plastic bags as soon as possible after collecting.

Root Samples

Place in plastic bags and cover with moist soil from the sample area.

Storage

Store samples at 5°C–10°C (40°C–50°F) and do not expose them to direct sunlight or extreme heat or cold (freezing). Only living nematodes can be counted. Accurate counts depend on proper handling of samples.

Submitting Plant for Disease Diagnosis or Identification

Sample Submission Forms

Forms can be obtained from your local Ontario Ministry of Agriculture, Food and Rural Affairs office. Carefully fill in all of the categories on the form. In the space provided, draw the most obvious symptom and the pattern of the disease in the field. It is important to include the cropping history of the area for the past three years and this year's pesticide use records.

Choose a complete, representative sample showing early symptoms. Submit as much of the plant as is practical, including the root system, or several plants showing a range of symptoms. If symptoms are general, collect the sample from an area where they are of intermediate severity. Completely dead material is usually inadequate for diagnosis.

With plant specimens submitted for identification, include at least a 20–25 cm sample of the top portion of the stem with lateral buds, leaves, flowers or fruits in identifiable condition. Wrap plants in newspaper and put in a plastic bag. Tie the root system off in a separate plastic bag to avoid drying

out and contamination of the leaves by soil. Do not add moisture, as this encourages decay in transit. Cushion specimens and pack in a sturdy box to avoid damage during shipping. Avoid leaving specimens to bake or freeze in a vehicle or in a location where they could deteriorate.

Delivery

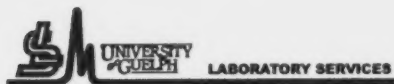
Deliver to the Pest Diagnostic Clinic as soon as possible by first class mail or by courier at the beginning of the week.

Submitting Insect Specimens for Identification

Collecting Samples

Place dead, hard-bodied insects in vials or boxes and cushion with tissues or cotton. Place soft-bodied insects and caterpillars in vials containing alcohol. Do not use water, as this results in rot. Do not tape insects to paper or send them loose in an envelope.

Place live insects in a container with enough plant "food" to support them during transit. Be sure to write "live" on the outside of the container.



95 Stone Road West
Guelph, ON N1H 8J7
Tel: (519) 767-6256
Fax: (519) 767-6240
Web: www.uoguelph.ca/pdc

Pest Diagnostic Clinic

SAMPLE SUBMISSION FORM

LABORATORY USE ONLY:		LS Form: SubP01/04/03
Rec'd: By: _____	Date Received: _____	
Delivered By: <input type="checkbox"/> Mail <input type="checkbox"/> Courier <input type="checkbox"/> In-Person		
LS Sample No: _____ to _____		
Payment Rec'd: \$ _____		Receipt #: _____

Submitted By: _____			Owner (if different from submitter): _____		
Business Name (if applicable): _____			Business Name (if applicable): _____		
Street: _____			Street: _____		
City: _____	Prov: _____	Postal Code: _____	City: _____	Prov: _____	Postal Code: _____
Tel: () - _____	Fax: () - _____		Tel: () - _____	Fax: () - _____	
Email: _____			Email: _____		
Unless otherwise indicated, report and invoice will be sent to submitter					
Report to: <input type="checkbox"/> Submitter <input type="checkbox"/> Owner			Required Report Format: <input type="checkbox"/> Fax <input type="checkbox"/> E-Mail <input type="checkbox"/> Mail		
Invoice to: <input type="checkbox"/> Submitter <input type="checkbox"/> Owner Quotation #: _____			Purchase Order / U of G G/L code: _____		
Services Required: <input type="checkbox"/> Nematode Count <input type="checkbox"/> Nematode Count from Roots <input type="checkbox"/> SCN Cyst & Egg Count <input type="checkbox"/> Verticillium Count <input type="checkbox"/> Plant Disease Diagnosis <input type="checkbox"/> Insect Identification <input type="checkbox"/> Plant Identification <input type="checkbox"/> Triazine Resistance Test					
Plant or Host Affected: _____			Cultivar/Variety: _____		Grower/Field sample #: _____
Location of Plant (i.e. greenhouse, field, orchard, garden, etc.): _____					
Size of Planting: _____	% of Plants Affected: _____	Symptoms First Appeared in Past: <input type="checkbox"/> Days <input type="checkbox"/> Weeks <input type="checkbox"/> Months <input type="checkbox"/> Years		Degree of Injury: <input type="checkbox"/> Severe <input type="checkbox"/> Moderate <input type="checkbox"/> Light	
Cropping History: _____			Future Crop: _____		

Describe the problem in detail (i.e. symptoms, plant parts affected, distribution of symptoms):

Were chemicals applied? Please specify type of product(s) used and date(s) of application:

Additional comments and specific requests:

Additional Sheet(s) Attached: ☐

APPENDIX E: Ontario Ministry of Agriculture, Food and Rural Affairs Crop Advisory Staff List

Brighton Resource Centre Tel: 613-475-1630 Fax: 613-475-3835 95 Dundas St. E., RR#3, Brighton, ON K0K 1H0			
IPM Systems Specialist	Margaret Appleby	Tel: 613-475-5850	margaret.appleby@ontario.ca
Guelph OMAFRA 1 Stone Rd. W., Guelph, ON N1G 4Y2			
Agroforestry Specialist	Todd Leuty	Tel: 519-826-3215 Fax: 519-826-3567	todd.leuty@ontario.ca
Crop Bioproducts Specialist	Mahendra Thimmanagari	Tel: 519-826-4593 Fax: 519-826-3567	mahendra.thimmanagari@ontario.ca
Crop Protection Program Lead	Denise Beaton	Tel: 519-6594 Fax: 519-826-4964	denise.beaton@ontario.ca
Director, Agriculture Development	Aileen MacNeil	Tel: 519-826-6588 Fax: 519-826-3567	aileen.macneil@ontario.ca
Manager, Field Crops	Brent Kennedy	Tel: 519-826-3257 Fax: 519-826-3567	brent.kennedy@ontario.ca
Manager, Greenhouse, Agroforestry and Specialty Crops	Annette Anderson	Tel: 519-826-3286 Fax: 519-826-3567	annette.anderson@ontario.ca
Manager, Horticulture Technology	Hugh Berges	Tel: 519-826-3288 Fax: 519-826-3567	hugh.berges@ontario.ca
Manager, Horticulture Crops	John Finlay	Tel: 519-826-6941 Fax: 519-826-3567	john.finlay@ontario.ca
Minor Use Coordinator	Jim Chaput	Tel: 519-826-3539 Fax: 519-826-4964	jim.chaput@ontario.ca
Organic Crop Production Program Lead	Hugh Martin	Tel: 519-826-4587 Fax: 519-826-4964	hugh.martin@ontario.ca
Potato Specialist	Eugenia Banks	Tel: 519-826-3678 Fax: 519-826-4964	eugenia.banks@ontario.ca
Product Development Specialist	Kelly Ward	Tel: 519-826-4094 Fax: 519-826-3567	kelly.lward@ontario.ca
Vegetable Crops Specialist	Jennifer Allen	Tel: 519-826-4963 Fax: 519-826-4964	jennifer.allen@ontario.ca
Harrow Tel: 519-738-2251 Fax: 519-738-4564 Greenhouse and Processing Crops Research Centre, 2585 County Road 20, Harrow, ON N0R 1G0			
Greenhouse Vegetable IPM Specialist	Gillian Ferguson	Tel: 519-738-1258	gillian.ferguson@ontario.ca
Greenhouse Vegetable Specialist	Shalin Khosla	Tel: 519-738-1257	shalin.khosla@ontario.ca
Weed Management – Horticulture Program Lead	Leslie Huffman	Tel: 519-738-1256	leslie.huffman@ontario.ca
Kemptville Resource Centre Tel: 613-258-8295 Fax: 613-258-8392 P.O. Box 2004, Concession Rd, Kemptville, ON K0G 1J0			
Agroforestry Specialist	vacant	Tel: 613-258-8302	
Emerging Crops Specialist	Scott Banks	Tel: 613-258-8359	scott.banks@ontario.ca
Field Crops, IPM Program Lead – Bilingual	Gilles Quesnel	Tel: 613-258-8250	gilles.quesnel@ontario.ca
Lindsay Resource Centre Tel: 705-324-6125 Fax: 705-324-1638 322 Kent St. W, Lindsay, ON K9V 2Z9			
Forage Specialist	Joel Bagg	Tel: 705-324-5856	joel.bagg@ontario.ca

APPENDIX E: Ontario Ministry of Agriculture, Food and Rural Affairs Crop Advisory Staff List (cont'd)

London Resource Centre Tel: 519-873-4070 Fax: 519-873-4062 667 Exeter Rd., London, ON N6E 1L3			
Apple Specialist	John Gardner	Tel: 519-873-4084	john.gardner@ontario.ca
New Liskeard Tel: 1-800-461-6132 Fax: 705-647-7993 280 Armstrong St., P.O. Box 4070, New Liskeard, ON P0J 1P0			
Agriculture and Rural Representative	Daniel Tassé	Tel: 705-647-2085	daniel.tasse@ontario.ca
Ridgetown Resource Centre Tel: 519-674-1690 Fax: 519-674-1564 Agronomy Building, Ridgetown College, P.O. Box 400, Main St. E, Ridgetown, ON N0P 2C0			
Entomology, Field Crops Program Lead	Tracey Baute	Tel: 519-674-1696	tracey.baute@ontario.ca
Pathologist – Field Crops Program Lead	Albert Tenuta	Tel: 519-674-1617	albert.tenuta@ontario.ca
Soil Management Specialist – Field Crops	Adam Hayes	Tel: 519-674-1621	adam.hayes@ontario.ca
Soil Management Specialist	Anne Verhallen	Tel: 519-674-1614	anne.verhallen@ontario.ca
Vegetable Crops Specialist	Janice LeBoeuf	Tel: 519-674-1699	janice.leboeuf@ontario.ca
Vegetable Crops Specialist	Elaine Roddy	Tel: 519-674-1616	elaine.rodny@ontario.ca
Simcoe Resource Centre Tel: 519-426-7120 Fax: 519-428-1142 P.O. Box 587, Blueline Rd. & Hwy #3, Simcoe, ON N3Y 4N5			
Berry Crop Specialist	Pam Fisher	Tel: 519-426-2238	pam.fisher@ontario.ca
Fresh Market Quality Program Lead	Jennifer R. DeEll	Tel: 519-426-1408	jennifer.deell@ontario.ca
Ginseng and Medicinal Herbs Specialist	vacant	Tel: 519-426-4323	
IPM Specialist – Specialty Crops	Melanie Filotas	Tel: 519-426-4434	melanie.filotas@ontario.ca
New Crop Development Specialist	vacant	Tel: 519-426-4509	
Pome Fruit IPM Specialist	Kathryn Carter	Tel: 519-426-4322	kathryn.carter@ontario.ca
Transition Crop Specialist	Jim Todd	Tel: 519-426-3823	jim.todd@ontario.ca
Stratford Resource Centre Tel: 519-271-0280 Fax: 519-273-5278 581 Huron St., Stratford, ON N5A 5T8			
Canola & Edible Beans Specialist	Brian Hall	Tel: 519-271-0083	brian.hall@ontario.ca
Cereals Specialist	Peter Johnson	Tel: 519-271-8180	peter.johnson@ontario.ca
Soil Fertility Specialist	Keith Reid	Tel: 519-271-9269	keith.reid@ontario.ca
Soybean Specialist	Horst Bohner	Tel: 519-271-5858	horst.bohner@ontario.ca
University of Guelph Tel: 519-824-4120 50 Stone Rd. E., Guelph, ON N1G 2W1			
Applied Research Coordinator – Field Crops, Crop Science Building	Ian McDonald	Tel: 519-824-4120 ext. 56707 Fax: 519-763-8933	ian.mcdonald@ontario.ca
Corn Industry Program Lead Crop Science Building	Greg Stewart	Tel: 519-824-4120 ext. 54865 Fax: 519-763-8933	greg.stewart1@ontario.ca

APPENDIX E: Ontario Ministry of Agriculture, Food and Rural Affairs Crop Advisory Staff List (cont'd)

Nursery Crops Specialist Edmund Bovey Building	Jennifer Llewellyn	Tel: 519-824-4120 ext. 52671 Fax: 519-767-0755	jennifer.llewellyn@ontario.ca
Nutrition – Horticulture Program Lead Land Resource Science, Richards Building	Christoph Kessel	Tel: 519-824-4120 ext. 52480 Fax: 519-824-5730	christoph.kessel@ontario.ca
Pathologist – Horticulture Crops Program Lead, Edmund Bovey Building	Michael Celetti	Tel: 519-824-4120 ext. 58910 Fax: 519-767-0755	michael.celetti@ontario.ca
Turfgrass Specialist, Guelph Turfgrass Institute 328 Victoria Rd. S., R.R. # 2 Guelph, ON N1H 6H8	Pam Charbonneau	Tel: 519-824-4120 ext. 52597 Fax: 519-766-1704	pamela.charbonneau@ontario.ca
Weed Management Field Crops Program Lead, Crop Science Building, Room 303	Mike Cowbrough	Tel: 519-824-4120 ext. 52580 Fax: 519-763-8933	mike.cowbrough@ontario.ca
Vineland – University of Guelph Tel: 905-562-4141 Fax: 905-562-3413 4890 Victoria Ave. N., P.O. Box 7000, Vineland Station, ON L0R 2E0			
Greenhouse Floriculture Specialist	Wayne Brown	Tel: 905-562-4141 ext. 179	wayne.brown@ontario.ca
Greenhouse Floriculture IPM Specialist	Graeme Murphy	Tel: 905-562-4141 ext. 106	graeme.murphy@ontario.ca
Vineland Resource Centre Tel: 905-562-4147 Fax: 905-562-5933 Adv. Serv. Building, P.O. Box 8000, 4890 Victoria Ave. N., Vineland Station, ON L0R 2E0			
Application Technology Specialist	Wendy McFadden-Smith	Tel: 905-562-3833	wendy.mcfadden-smith@ontario.ca
Entomology, Horticulture Program Lead	Hannah Fraser	Tel: 905-562-1674	hannah.fraser@ontario.ca
Nutrient Management Horticulture Crops Program Lead	Donna Speranzini	Tel: 905-562-1170	donna.speranzini@ontario.ca
Tender Fruit and Grape IPM Specialist	vacant		
Tender Fruit and Grape Specialist	Ken Slingerland	Tel: 905-562-1639	ken.slingerland@ontario.ca
Woodstock Resource Centre Tel: 519-537-6621 Fax: 519-539-5351 P.O. Box 666, Hwy. #59 N, Woodstock, ON N4S 7Z5			
Nutrient Management Field Crops Program Lead	Christine Brown	Tel: 519-537-8305	christine.brown1@ontario.ca

Agricultural Information Contact Centre

Provides province-wide, toll-free technical and business information to commercial farms, agri-businesses and rural businesses.

1 Stone Rd. W., Guelph, ON N1G 4Y2

Tel: 1-877-424-1300 Fax: 519-826-3442 E-mail: ag.info.omafra@ontario.ca

Guelph – ServiceOntario

1 Stone Rd. W., Guelph, ON N1G 4Y2 Staff Directories – Phone 1-888-466-2372 or 519-826-3100

APPENDIX F: Ontario Ministry of the Environment – Regional Offices Contact Information

Region County/Township	Pesticide Specialist(s) Mailing Address	Telephone/ Toll-free/Fax
Central Region Toronto, Halton, Peel, York and Durham	5775 Yonge St., 8th Floor Toronto, ON M2M 4J1	Tel: 416-326-6700 Toll-free: 1-800-810-8048 Fax: 416-325-6347
West-Central Region Haldimand, Norfolk, Niagara, Hamilton-Wentworth, Dufferin, Wellington, Waterloo, Brant	119 King St. W., 12th Floor Hamilton, ON L8P 4Y7	Tel: 905-521-7640 Toll-free: 1-800-668-4557 Fax: 905-521-7820
Eastern Region Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville, Prescott & Russell, Stormont/ Dundas & Glengarry Peterborough, Kawartha Lakes, Northumberland, Renfrew, Ottawa, Lanark, District of Nipissing (Twp. of South Algonquin), Haliburton	133 Dalton Ave. Kingston, ON K7L 4X6	Tel: 613-549-4000 Toll-free: 1-800-267-0974 Fax: 613-548-6908
Southwestern Region Elgin, Middlesex, Oxford, Essex, Kent, Lambton, Bruce, Grey, Huron, Perth, Muskoka, Simcoe	733 Exeter Rd. London, ON N6E 1L3	Tel: 519-873-5000 Toll-free: 1-800-265-7672 Fax: 519-873-5020
Northern Region (East) Manitoulin, Nipissing, Parry Sound, Sudbury, Algoma (East), Timiskaming, Sault Ste. Marie	199 Larch St., Suite 1101 Sudbury, ON P3E 5P9	Tel: 705-564-3237 Toll-free: 1-800-890-8516 Fax: 705-564-4180
Northern Region (West) Algoma (West), Cochrane, Kenora, Rainy River, Timmins, Thunder Bay	435 James St. S., Suite 331 Thunder Bay, ON P7E 6S7	Tel: 807-475-1205 Toll-free: 1-800-875-7772 Fax: 807-475-1754

APPENDIX G: Other Contacts**AGRICULTURE & AGRI-FOOD
CANADA RESEARCH CENTRES****Eastern Cereals and Oilseeds Research
Centre**

960 Carling Ave.
Ottawa, ON K1A 0C6
Tel: 613-759-1952
http://res2agr.ca/ecorc/index_e.htm

**Greenhouse and Processing Crops
Centre**

2585 County Rd. 20
Harrow, ON N0R 1G0
Tel: 519-738-2251
<http://res2.agr.ca/harrow/>

**Southern Crop Protection and Food
Research Centre**

1391 Sandford St.
London, ON N5V 4T3
Tel: 519-457-1470
http://res2.agr.ca/london/pmrc/index_e.htm

Vineland Research Farm

4902 Victoria Ave. N.
Vineland, ON L0R 2E0
Tel: 905-562-4113
http://res2.agr.ca/london/pmrc/index_e.htm

Delhi Research Farm

P.O. Box 186 Schafer Rd.
Delhi, ON N4B 2W9
Tel: 519-582-1950
http://res2.agr.ca/london/pmrc/index_e.htm

**CANADIAN FOOD INSPECTION
AGENCY REGIONAL OFFICES
(PLANT PROTECTION)**

www.inspection.gc.ca/english/toce.shtml

Belleville

345 College St. E
Belleville, ON K8N 5S7
Tel: 613-969-3330

Hamilton

709 Main St. W., Suite 101
Hamilton, ON L8S 1A2
Tel: 905-572-2201

London

1900 Commissioners Rd. E.
London, ON NSZ 4R3
Tel: 519-691-1300

St. Catharines

395 Ontario St., P.O. Box 19
St. Catharines, ON L2N 7N6
Tel: 905-937-8232

Ottawa District

38 Auriga Dr., Unit 8
Ottawa, ON K2E 8A5
Tel: 613-274-7374 ext. 221

Toronto

1124 Finch Ave. W., Unit 2
Downsview, ON M3J 2E2
Tel: 416-665-5055
Fax: 416-665-5069

UNIVERSITY OF GUELPH**Main Campus**

Guelph, ON N1G 2W1
Tel: 519-824-4120
www.uoguelph.ca

Alfred Campus

Alfred, ON K0B 1A0
Tel: 613-679-2218
Fax: 613-679-2423
www.alfredc.uoguelph.ca

Kemptville Campus

Kemptville, ON K0G 1J0
Tel: 613-258-8336
Fax: 613-258-8384
www.kemptvillec.uoguelph.ca

Ridgetown Campus

Ridgetown, ON N0P 2C0
Tel: 519-674-1500
www.ridgetownc.on.ca

Department of Plant Agriculture

Department of Plant Agriculture, Guelph
50 Stone Rd. W.
Guelph, ON N1G 2W1
Tel: 519-824-4120 ext. 53391
Fax: 519-763-8933
www.plant.uoguelph.ca

**Department of Plant Agriculture,
Simcoe**

1283 Blueline Road
P.O. Box 587
Simcoe, ON N3Y 4N5
Tel: 519-426-7127
Fax: 519-426-1225
www.plant.uoguelph.ca

**Department of Plant Agriculture,
Vineland**

4890 Victoria Ave. N.
P.O. Box 7000
Vineland Station, ON L0R 2E0
Tel: 905-562-4141
Fax: 905-562-3413
www.plant.uoguelph.ca

Lab Services Division

www.uoguelph.ca/labserv/

Pesticide and Trace Contaminants

95 Stone Rd. W.
P.O. Box 3650
Guelph, ON N1H 8J7
Tel: 519-767-6200

Pest Diagnostic Clinic

95 Stone Rd. W.
Guelph, ON N1H 8J7
Tel: 519-767-6256

APPENDIX H: Production Insurance

The Canada-Ontario Crop Insurance Program is publicly funded by the Government of Canada and the Province of Ontario and delivered by Agricorp. The federal and provincial governments contribute up to 60 % of the premium cost and 100 % of the administrative costs. Both these contributions enable an Ontario grower to purchase insurance coverage at a substantially reduced cost.

The grower's payment is considered an operating expense for income tax purposes. As long as recommended control practices are followed, Production Insurance offers protection against a broad range of production hazards, including excessive rain, hail,

excessive drought, freeze, frost, excessive wind, insect infestation and plant disease.

For further information, please call Agricorp at 1-888-247-4999.

Agricorp
1 Stone Rd. W.
P.O. Box 3660
Stn. Central, Guelph, ON N1H 8M4
Tel: 1-888-247-4999
Fax: 519-826-4118
contact@agricorp.com
www.agricorp.com

Ontario Crops Covered by a Production Insurance Plan

Fruit Crops		
apples and apple trees	cherries, sweet and sour	grapes and grape vines
peaches/nectarines	pears	plums
strawberries		
Vegetable Crops – Average Farm Yield or Total Production		
asparagus	banana peppers	bell peppers
broccoli	green beans and wax beans (processing)	butternut squash (processing)
cabbages	carrots (fresh)	carrots (processing)
cauliflower	celery	cucumbers (processing)
lettuce	lima beans (processing)	parsnips
peas (processing)	potatoes (fresh)	potatoes (processing)
red beets (processing)	rutabagas	seed onions
set onions	spanish onions	sweet corn (fresh)
sweet corn (processing)	tomatoes (processing)	tomatoes (fresh)
Fresh Market Vegetables – Acreage Loss		
root vegetables (red beets, carrots, celeriac, french shallots, green onions, leeks, onions, parsnips, radishes, rutabagas and turnips)	leafy vegetables (brussels sprouts, broccoli, cauliflower, broccoflower, celery, chinese cabbages, green cabbage, lettuce, mesclun and spinach)	fruit vegetables (cucumbers, eggplant, gherkins, melons, peppers, pumpkins, squash, tomatoes and zucchini)
other vegetables (broad beans, fresh market beans, sweet corn, green peas)		
General Crops		
colored beans (black, cranberry, kidney, japanese/other)	organic winter spelt	soybeans (tofu, natto and organic options available)
canola	mustard	organic winter wheat
corn (grain and silage)	seed corn	forage
new forage seeding	honey	peanuts
popping corn	industrial hemp	spring grain
sugarbeets	sunflower	spring wheat
hard red winter wheat	soft red winter wheat	soft white winter wheat
Tobacco		
black	flue-cured	burley

APPENDIX I: The Metric System

Metric Units

Linear Measures (length)	
10 millimetres (mm)	= 1 centimetre (cm)
100 centimetres (cm)	= 1 metre (m)
1,000 metres	= 1 kilometre (km)
Square Measures (area)	
100 m × 100 m = 10,000 m ²	= 1 hectare (ha)
100 ha	= 1 square kilometre (km ²)
Cubic Measures (volume)	
<i>Dry Measure</i>	
1,000 cubic millimetres (mm ³)	= 1 cubic centimetre (cm ³)
1,000,000 cm ³	= 1 cubic metre (m ³)
<i>Liquid Measure</i>	
1,000 millilitres (mL)	= 1 litre (L)
100 L	= 1 hectolitre (hL)
Weight-Volume Equivalents (for water)	
(1.00 kg) 1,000 grams	= 1 litre (1.00 L)
(0.50 kg) 500 g	= 500 mL (0.50 L)
(0.10 kg) 100 g	= 100 mL (0.10 L)
(0.01 kg) 10 g	= 10 mL (0.01 L)
(0.001 kg) 1 g	= 1 mL (0.001 L)
Weight Measures	
1,000 milligrams (mg)	= 1 gram (g)
1,000 g	= 1 kilogram (kg)
1,000 kg	= 1 tonne (t)
1 mg/kg	= 1 part per million (ppm)
Dry-Liquid Equivalents	
1 cm ³	= 1 mL
1 m ³	= 1000 L
Metric Conversions	
5 mL	= 1 tsp
15 mL	= 1 tbsp
28.5 mL	= 1 fl. oz.

Application Rate Conversions

Metric to Imperial (Approximate)	
litres per hectare × 0.09	= gallons per acre
litres per hectare × 0.36	= quarts per acre
litres per hectare × 0.71	= pints per acre
millilitres per hectare × 0.015	= fluid ounces per acre
grams per hectare × 0.015	= ounces per acre
kilograms per hectare × 0.89	= pounds per acre
tonnes per hectare × 0.45	= tons per acre
Imperial to Metric (Approximate)	
gallons per acre × 11.23	= litres per hectare (L/ha)
quarts per acre × 2.8	= litres per hectare (L/ha)
pints per acre × 1.4	= litres per hectare (L/ha)
fluid ounces per acre × 70	= millilitres per hectare (mL/ha)
tons per acre × 2.24	= tonnes per hectare (t/ha)
pounds per acre × 1.12	= kilograms per hectare (kg/ha)
ounces per acre × 70	= grams per hectare (g/ha)
Liquid Equivalents	
Litres/Hectare	Approximate Gallons/Acre
50	= 5
100	= 10
150	= 15
200	= 20
250	= 25
300	= 30

Dry Weight Equivalents

Grams or Kilograms / Hectare	Ounces or Pounds /Acre
100 grams	= 1 1/2 ounces
200 grams	= 3 ounces
300 grams	= 4 1/4 ounces
500 grams	= 7 ounces
700 grams	= 10 ounces
1.10 kilograms	= 1 pound
1.50 kilograms	= 1 1/4 pounds
2.00 kilograms	= 1 3/4 pounds
2.50 kilograms	= 2 1/4 pounds
3.25 kilograms	= 3 pounds
4.00 kilograms	= 3 1/2 pounds
5.00 kilograms	= 4 1/2 pounds
6.00 kilograms	= 5 1/4 pounds
7.50 kilograms	= 6 3/4 pounds
9.00 kilograms	= 8 pounds
11.00 kilograms	= 10 pounds
13.00 kilograms	= 11 1/2 pounds
15.0 kilograms	= 13 1/2 pounds

Conversion Tables – Metric to Imperial

Length	1 millimetre (mm) = 0.04 inch 1 centimetre (cm) = 0.40 inch 1 metre (m) = 39.40 inches 1 metre (m) = 3.28 feet 1 metre (m) = 1.09 yards 1 kilometre (km) = 0.62 mile
Area	1 square centimetre (cm ²) = 0.16 square inch 1 square metre (m ²) = 10.77 square feet 1 square metre (m ²) = 1.20 square yards 1 square kilometre (km ²) = 0.39 square mile 1 hectare (ha) = 107,636 square feet 1 hectare (ha) = 2.5 acres
Volume (dry)	1 cubic centimetre (cm ³) = 0.061 cubic inch 1 cubic metre (m ³) = 1.31 cubic yards 1 cubic metre (m ³) = 35.31 cubic feet 1,000 cubic metres (m ³) = 0.81 acre-foot 1 hectolitre (hL) = 2.8 bushels
Volume (liquid)	1 millilitre (mL) = 0.035 fluid ounce 1 litre (L) = 1.76 pints 1 litre (L) = 0.88 quart 1 litre (L) = 0.22 gallon (Imp.) 1 litre (L) = 0.26 gallon (U.S.)
Weight	1 gram (g) = 0.035 ounce 1 kilogram (kg) = 2.21 pounds 1 tonne (t) = 1.10 short tons 1 tonne (t) = 2.205 pounds
Pressure	1 kilopascal (kPa) = 0.15 pounds/in ²
Speed	1 metre per second = 3.28 feet per second 1 metre per second = 2.24 miles per hour 1 kilometre per hour = 0.62 mile per hour
Temperature	°F = (°C × 9/5) + 32

Handy Metric Conversion Factor

Litres per hectare × 0.4 = litres per acre
Kilograms per hectare × 0.4 = kilograms per acre

Conversion Tables – Imperial to Metric

Length	1 inch = 2.54 cm 1 foot = 0.30 m 1 yard = 0.91 m 1 mile = 1.61 km
Area	1 square foot = 0.09 m ² 1 square yard = 0.84 m ² 1 acre = 0.40 ha
Volume (dry)	1 cubic yard = 0.76 m ³ 1 bushel = 36.37 L
Volume (liquid)	1 fluid ounce (Imp.) = 28.41 mL 1 pint (Imp.) = 0.57 L 1 gallon (Imp.) = 4.55 L 1 gallon (U.S.) = 3.79 L
Weight	1 ounce = 28.35 g 1 pound = 453.6 g 1 ton = 0.91 tonne
Pressure	1 pound per square inch = 6.90 kPa
Temperature	°C = (°F – 32) × 5/9

Abbreviations

% = per cent (by weight)	kPa = kilopascal
ai = active ingredient	L = litre
cm = centimetre	m = metre
cm ² = square centimetre	m/s = metres per second
e.g. = for example	m ² = square metre
g = gram	mL = millilitre
ha = hectare	mm = millimetre
kg = kilogram	t = tonne
km/h = kilometres per hour	

Spraying Record

Spraying Record

Spraying Record

Emergency and First-Aid Procedures for Pesticide Poisoning

For a major spill, a theft or a fire involving a pesticide call the Ministry of the Environment at
1-800-268-6060.

For pesticide poisonings and pesticide injuries call the Poison Information Centre:
Toronto 1-800-268-9017
Hearing Assistance (TTY) 1-877-750-2233

PREVENT ACCIDENTS

- **Read the label.** Follow all the precautions the label recommends. Read the First Aid section of the label **BEFORE** you begin to handle any pesticide.
- **Make sure that someone knows** what pesticides you are working with and where you are.
- **Keep a file of labels and product Material Safety Data Sheets (MSDS) for the pesticides you use.** Make sure everyone knows where to find this in case of an emergency.
- **Post emergency numbers near all telephones.**
- **Keep clean water, paper towels, extra gloves and clean coveralls close by** in case you spill pesticide on yourself.

If someone has been working with pesticides and you see any possible symptoms of pesticide poisoning or injury, take emergency action immediately.

IF AN ACCIDENT OR POISONING HAPPENS

- Protect yourself from injury first.
- Stop the exposure to the pesticide. Move the victim away from the contaminated area.
- Check the four basic facts — identify the pesticide, the quantity, the route of entry and time of exposure.
- Call an ambulance or the Poison Information Centre.
- Start first aid. This is not a substitute for professional medical help.
- **Provide the label, MSDS sheet or container to emergency personnel** at the scene — or take it with you to the hospital. Do not transport pesticide containers in the passenger compartment of the vehicle.

FIRST AID

If a pesticide comes in contact with skin:

- remove all contaminated clothing; wash skin thoroughly with lots of soap and warm water
- dry skin well and cover with clean clothing or other clean material.

If pesticide comes in contact with eyes:

- hold eyelids open; wash the eyes with clean running water for 15 minutes or more.

If pesticide was inhaled:

- move the victim to fresh air and loosen tight clothing
- give artificial respiration if the victim is not breathing.

Do not breathe in the exhaled air from the victim — you could also be poisoned.

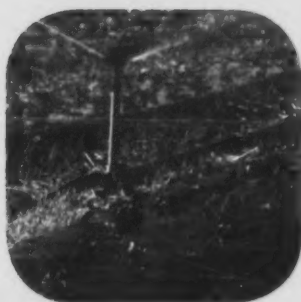
If a pesticide was swallowed:

- **call the Poison Information Centre IMMEDIATELY.**

Emergency numbers are listed at the front of each Bell telephone directory.

For information, or to obtain copies of this or any other ministry publication please:
call 1-888-466-2372 from within Ontario, 519-826-3700 from outside the province or OMAFRA's TTY line at 519-826-7402 for the hearing impaired, e-mail your request to products.omafra@ontario.ca, or visit OMAFRA's website at ontario.ca/omafra.

A complete list of all OMAFRA products and services, and order forms, are available on the website. Orders can be faxed to 519-826-3633 or mailed to ServiceOntario, 1 Stone Road West, Guelph, Ontario N1G 4Y2.



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